REPORT RESUMES

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PETROLEUM AND PETROLEUM PRODUCTS SALES AND SERVICE. AGRICULTURAL SUPPLY - SALES AND SERVICE OCCUPATIONS, MODULE NUMBER 11.

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THE PURPOSE OF THIS GUIDE IS TO ASSIST TEACHERS IN PREPARING HIGH SCHOOL AND POST-HIGH SCHOOL STUDENTS FOR ENTRY AND ADVANCEMENT IN THE PETROLEUM PHASE OF AGRICULTURAL SUPPLY OCCUPATIONS. ONE OF A SERIES FOR AGRICULTURAL SUPPLY OCCUPATIONS, THIS MODULE WAS DEVELOPED BY A NATIONAL TASK FORCE ON THE BASIS OF DATA FROM STATE STUDIES. SECTIONS ARE (1) FUEL SELECTION, (2) FUEL STORAGE, (3) MOTOR LUBRICATING OIL SELECTION, (4) GEAR, HYDRAULIC, AND LUBRICATING OILS AND GREASES, (5) HEATING OIL SELECTION, DELIVERY, AND STORAGE, (6) OTHER PRODUCTS, (7) CONTRACTUAL RELATIONSHIPS, (8) SAFETY, AND (9) TRUCK DRIVING. SUGGESTIONS FOR INTRODUCING THE MODULE AND EVALUATING THE EDUCATIONAL OUTCOMES, AND SOURCES OF INSTRUCTIONAL MATERIAL ARE GIVEN. EACH SECTION INCLUDES SUBJECT MATTER CONTENT, TEACHING-LEARNING ACTIVITIES, AND INSTRUCTIONAL AIDS AND REFERENCES. TEACHERS SHOULD HAVE EXPERIENCE IN AGRICULTURAL SUPPLY, AND STUDENTS SHOULD HAVE AN OCCUPATIONAL GOAL IN THE FIELD. THE MATERIAL IS DESIGNED FOR 38 HOURS OF CLASS INSTRUCTION, 10 HOURS OF LABORATORY EXPERIENCE, AND 40 HOURS OF OCCUPATIONAL EXPERIENCE. THIS DOCUMENT IS AVAILABLE FOR A LIMITED PERIOD AS PART OF A SET (VT 000 632 - 000 644) FOR $7.00 FROM THE CENTER FOR VOCATIONAL AND TECHNICAL EDUCATION, THE OHIO STATE UNIVERSITY, 980 KINNEAR ROAD, COLUMBUS, OHIO 43212. (JM)

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PETROLEUM & PETROLEUM PRODUCTS SALES AND SERVICE

One of Twelve Modules in the Course Preparing for Entry in

AGRICULTURAL SUPPLY - SALES AND SERVICE OCCUPATIONS

Module No. 11

The Center for Research and Leadership Development
in Vocational and Technical Education

The Ohio State University
980 Kinnear Road
Columbus, Ohio, 43212

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MEMORANDUM

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DATE: August 7, 1967

RE: (Author, Title, Publisher, Date) Module No. 11, "Petroleum and Petroleum Products - Sales and Service," The Center for Vocational and Technical Education, August, 1965.

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Necessary x
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(Check Which)

Describe Suggested references given in module. (P)

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PETROLEUM AND PETROLEUM PRODUCTS - SALES AND SERVICE

Major Teaching Objective

To develop the understanding and abilities needed to become employed and to advance in the petroleum phase of Agricultural Supply - Sales and Service Occupations.

Suggested Time Allotments

At school		
Class instruction	38 hours	
Laboratory experience	10 hours	
Total at school		48 hours
Occupational experience		40 hours*
Total for module		88 hours*

Note to teacher:

It is realized that the subject matter content of this module is written on the "high side" for high school students. This was done to take care of the high school students and also to serve the post-high school groups. Due to the lack of opportunity for occupational experience until after a student reaches his eighteenth birthday, only a brief coverage during the senior year with a more complete treatment at the post-high school level, is indicated. Maturity, as a requirement for this occupation, is most important and cannot be overstressed.

It is suggested that all of the competencies listed for the module be covered at the high school level. The technical material or related science material beyond easy comprehension of the students should be deferred to post-high school courses. The teacher should appraise his class and determine how deeply to go into the subject matter content. In the teaching of additives, for example, it may be sufficient for high school groups to identify them by name and general function. This may be illustrated by tetraethyl lead and its anti-knock function.

Suggestions for Introducing the Module

Petroleum and its products are handled by many agricultural supply businesses and its distribution to farmers performs a much needed service. Because of this, there is a limited, but definite, need for persons either in sales or service occupations. Unless a business is unusually large, retail sales are carried on by non-specialists and orders for delivery are handled as a part of the general work load. The jobs of delivering to and servicing farmers as well as operating any storage facilities usually require men with some experience rather than young men just graduating from high school.

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* The figures for occupational experience are minimal in view of the limited opportunities for wage-earning employment in the petroleum product sales and service divisions of agricultural businesses while students are in high school.

Very few agricultural supply businesses, except in some midwestern states, operate service stations comparable with those of the major oil companies. In most states, young men must be at least 18 years of age before they can secure a license to operate a tank truck, and there is practically no need for a "helper." Company policy may preclude riding as an observer. However, the willingness of rural youth for hard work, their reputation for reliability, and their ability to speak the farmers' language, gives them an advantage when being considered for employment as salesmen, or in some cases, as driver-salesmen.

The major portion of the petroleum business in a farm supply center is in products delivered to the farm such as gasoline, heating oil, and lubricants. Store sales are largely confined to kerosene, oils, lubricating greases and accessories. While the ability to drive a truck properly is often a major consideration for employment, the eventual value to the company and the amount of individual earnings will depend upon the individual's sales ability and the rapport he establishes with his customers. This module emphasizes the sales and service aspects of the delivery of petroleum products to the farmer and retail sales work in the farm supply store.

An informal survey of the opportunities for employment in this field with the class will be a good way to introduce the module. The students should immediately become aware that they cannot hope to become deliverymen servicing farmers until they are mature enough to assume the responsibility associated with such a job. They will not be driving a large truck loaded with potentially explosive products, and making recommendations as a business man immediately upon graduation from high school.

State research studies to supplement the local survey may be helpful in identifying the opportunity for employment in concerns handling petroleum products. It is entirely possible that the potential for employment in this particular area of agricultural supply - sales and service occupations may not justify the teaching of this module on the high school level. In that case, selected area vocational schools may provide the training at the post-high school level for students who have a positive interest in becoming outside salesmen to meet the needs of the farm supply business.

At this point it would be helpful to identify the occupational title of workers in the petroleum area of agricultural supply occupations. In the current edition of the Dictionary of Occupational Titles all workers are included under the petroleum industry. However, in the revised edition soon to be available, it is understood that a different method of grouping will be followed. The October, 1964, draft of The Occupational Classification Structure for the revised Dictionary of Occupational Titles[1], indicates a classification for "Salesmen and sales persons, fuel and petroleum products."

Hoover, in his Handbook of Agricultural Occupations[2] lists the title. "Truck Driver for a Rural Gasoline and Oil Distributor," which seems to accentuate the delivery and service aspect and plays down the importance of sales. However, in the career brief, the author indicates that although the driver loads his truck, makes deliveries, prepares sales slips and keeps records, he is also a salesman and works to establish good customer relations and to secure new customers. It will be helpful for the teacher and his students to go over this career brief to be found on page 130 of this handbook to see how the information applies to the local situation. This information is presented under the headings of: (1) Description and Nature of Work, (2) Working Conditions, (3) Educational and Personal Qualifications, and (4) How to Enter and Advance in the Occupation.

Practically all driver-salesmen operate under some kind of an incentive plan which rewards the individual who has initiative, ability to learn, and ability to sell his services as well as his product. A person who is content to remain a truck driver or product delivery man will make a satisfactory living. The individual who is willing to develop his sales technique to the level where his volume increases and the route shortens may develop the job into a lifetime career at a higher income.

Advancement may be from a route man to a full-time outside salesman or directly to petroleum manager for a farm supply center or petroleum distributor. Some individuals may have the ability and capacity to progress in management to assistant and then to general manager of an agricultural supply business. A few individuals may establish their own business, buying wholesale and delivering to retail customers on the farm or in rural communities. Since this involves a tremendous investment in storage facilities and trucks, this person is probably better off working for a company for several years rather than attempting an individual business which is under-capitalized.

The occupational title of Petroleum Engineer pertains to the professional field of activity for which a college degree is necessary. The title of Petroleum Specialist growing out of the research study now in progress at the National Center for Vocational and Technical Education envisages technical activities of a sub-professional nature not requiring a B.S. degree, but for which post-high school training would be necessary. While it would be possible for a high school graduate to advance from driver-salesman to a petroleum specialist by additional training, this module considers only the competency required of a driver-salesman or inside salesman.

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[1] Dictionary of Occupational Titles, Volume II, U. S. Department of Labor. U. S. Government Printing Office, Washington, D. C.

[2] Hoover, Norman K. Handbook of Agricultural Occupations, Danville, Illinois: The Interstate Printers and Publishers, Inc., 254 pages.

There is limited opportunity for working initially as a helper and eventually as the person responsible for the delivery and installation of storage tanks to farms. This is usually done by someone other than the driver-salesman, since it requires a different kind of truck and usually requires more additional time than a man with a full schedule has available. However, small businesses or drivers with routes which do not require full time might combine delivery or service of the tanks with normal deliveries.

After the class understands the general nature of the work and the possibilities for employment, the next step in the introduction of the module would be to develop a list of the understandings, abilities, and skills they would need for employment. This can start with the simple question, "What do you need to know, or be able to do, in order to become a petroleum driver-salesman?" The students' answers can be listed on the chalkboard as they give them, and then re-worded into the competencies which may be stated as follows:

I. To be able to select lubricating oils correctly

II. To be able to select and store gear oils, greases, and hydraulic oils correctly

III. To be able to select tractor and power equipment fuels correctly

IV. To be familiar with other products usually available to farmers through the salesman of petroleum products

V. To understand the design and placement of proper storage facilities for fuels on farms

VI. To understand the proper selection and storage of heating oils

VII. To understand and apply the safety laws and regulations pertaining to the delivery and storage of petroleum products

VIII. To understand the contractual relationship of the company to the delivery driver and the driver to the customer

IX. To be able to meet the requirements for a chauffeur's license and for operating a truck carefully and safely

X. ______________________________(The class or teacher should add to this list as they see fit.)

Since no specialized inside salesperson in petroleum products will be needed in the usual farm supply store operation, the teaching material of the module is directed primarily toward the driver-salesman. However, all inside salespersons should be familiar with each of the competencies and as well qualified as the driver-salesman in competency No. III, competency No. IV, and competency No. VI. These are the policies concerned with lubricating oils, gear oils and greases, and accessories such as tires.

While it is not intended that this module be used for the training of filling station attendants, achievement of some of the competencies will qualify an individual in these products regardless of where he works. Competencies I, III, IV and VI pertain to tractor fuels, lubricating oil, gear oils and greases, and other products available to farmers. In the same way, the competencies regarding storage facilities and safety, which are No. II and No. VIII are applicable to filling station attendants although they are written for farm delivery personnel.

Success in Petroleum Products - Sales and Service can be achieved if the farmer can be persuaded to start, and continue to use your products.

To do this you must (1) know what you have to offer, (2) discover what the farmer needs, (3) arrange for ordering and delivery in the most efficient manner and (4) build confidence in the customer that you are knowledgeable and reliable in meeting his needs. If you can do this, he will stay with you rather than try your competitors.

Competencies to be Developed

I. To be able to select tractor and power equipment fuels correctly

Teacher Preparation

Subject Matter Content

The major source of income to the driver-salesman is from delivering tractor fuels to farmers. He has almost as great a stake as the farmer in being sure that the right fuel is used for a given tractor. A poor recommendation, or a mistake in delivery, might lose a customer and cut the volume which helps determine the paycheck.

Today's tractors are designed to operate best on one type and grade of fuel. In the operator's manual, the manufacturer is specific as to the fuel to use, and farmers should read these manuals and follow the recommendations. However, some farmers discard the manual soon after receiving it and tend to forget it, especially if they have several different tractors on their farms. Operator's manuals rarely accompany a used tractor when it changes hands, and the new owner expects that the deliveryman will know the type of fuel he should use. Most major oil companies provide their drivers with handbooks or reference sheets so they can be accurate in recommending the exact fuel which should be used with every model of tractor. Production and distribution of these sheets involves considerable expense which is justified only if the driver uses the information to promote his sales with farmers.

Students may have acquired a general knowledge of fuels for tractors from other high school courses, particularly vocational agriculture. It is suggested that the teacher determine how deeply he should go into the subject of tractor fuels before finalizing his teaching plan for this competency.

Tractor fuels are treated under modules 14, "Gasoline Tractor Engine Systems," and 15, "Diesel Engine Systems," of the course outline for AGRICULTURAL MACHINERY - Sales and Service Occupations. This is available from The Center for Vocational and Technical Education, The Ohio State University, 980 Kinnear Road, Columbus, Ohio, 43212. However, it is believed that the following brief presentation will assist the teacher of this course in his specialized treatment for driver-salesman and also serve as a review outline for students whose competency has been ascertained previously.

1. Selecting fuel for gasoline tractors

More tractors use gasoline than any other type of fuel, even though it costs more per gallon, contains less energy per gallon, and gasoline engines run at higher speeds with increased resulting wear. Kerosene, "distillate" and other lower-grade fuels can be successfully used in tractors and have relatively more energy in them, but their popularity has decreased as the spread in prices has decreased. This is due to the increase in the supply of gasoline as the result of improved techniques in refining, known as "catalytic cracking." It is now possible to make 57% of a barrel of crude oil into gasoline compared to 23% before the use of the "cracking" process. This has enabled refineries to keep the cost of gasoline down so that the price spread between gasoline and distillates is much less than five cents per gallon and gasoline can be economically used in tractors.

Along with improved refining came the increase in the development of anti-knock properties for gasoline which has a normal octane rating of 80-90. Manufacturers adjust their product according to the seasons of the year to give the most satisfactory service.

The regular grade of gasoline should be satisfactory for tractors regardless of the time of the year, as the reliable producer sees to it that it has three qualities:

a. Proper octane rating

b. Easy starting properties

c. Freedom from dirt, gum and foreign matter

The term "octane rating" or "octane number rating" is the method established by the American Society for Testing Materials (ASTM), for comparing the anti-knock qualities of fuels used in spark ignition engines. Zero was the value arbitrarily assigned to a fuel known as Normal Heptane, that has very poor anti-knock properties. When mixed with another fuel known as Iso-Octane, having excellent anti-knock properties, which was assigned the value of 100, it was possible to develop a graduated scale of anti-knock properties according to the proportion of Iso-Octane to Normal Heptane. When a given fuel is run in a test engine and the proportion of the two testing fuels is varied until the anti-knock quality is equal, the proportion of Iso-Octane determines the octane number. Thus, if a fuel being tested gives the same anti-knock performance as 80 parts Iso-Octane and 20 parts of heptane, the octane number is 80. While the anti-knock properties of gasoline have been improved by advances in the refining industry, it is always necessary to add some additional material to economically raise the octane rating.

The additive most usually used for this purpose is tetraethyl lead, although other lead compounds are now being used as physical mixtures of chemical compounds of lead. The physical mixtures of bad compounds are Tetra-ethyl lead, abbreviated TEL, and tetra methyl lead, abbreviated TML. The chemical compounds of lead are lead alkyls. The addition of very small amounts of these chemicals brings a marked improvement in the anti-knock qualities. Three milliliters of TEL per gallon of gasoline will raise the octane rating by 10.

Nothing is more provoking to the farmer than not being able to start his tractor in the winter, or having it be hard to re-start in the summer. To avoid these difficulties, the producer changes specifications or "blending" for the regular grade of gasoline at least twice and usually four times a year. This may be done to increase the "volatility" or tendency to evaporate more readily and promote easier starting in the winter when the weather is cold. This might also be done to reduce the volatility in the summer, which causes difficulty in re-starting after stopping, sometimes caused by volatile gases blocking the passage of gasoline through the lines.

The manufacturer does not usually inform the customer of the seasonal changes in blending, but the deliveryman can provide this information. He should advise his patrons in case they are stocking up too heavily at the time of the year changes are being made. It is never advisable to hold gasoline too long because of the loss of the "lighter ends" through evaporation. The farmer should not, therefore, carry a full tank of summer gas over for use in the cold months.

A farmer wants his tractor to start easily, run with normal power and continue to run dependably. If it does not, he immediately suspects dirt or water in the gasoline. When the valves "hold open," he suspects that gum has been deposited on the valve stems from poor gasoline. In reality, the manufacturer and distributor are not responsible for any of these conditions, but it takes a tactful driver-salesman to explain that the manufacturer is not at fault because of the following:

a. The precautions taken to keep dirt out of the gasoline until it goes into the farmer's tank

b. The precautions taken to control moisture in bulk tanks and removal of moisture, when necessary, before it is pumped into the delivery truck

c. The addition of chemicals during the refining process to prevent the accumulation of gum

d. That any dirt or moisture contamination probably occurred on the farm and can be controlled by proper storage tank installation and use (See competency No. II of this module.)

2. Selecting Fuels for Diesel Tractors

Diesel tractors have a higher initial cost, but are becoming increasingly popular because they provide more power from a cheaper fuel. They have a reputation for running on "anything" and were originally designed to use pulverized coal, but adequate performance is highly dependent on using the right quality of fuel.

Fuel injectors on diesel tractors replace the spark plugs and conventional carburetors of gasoline tractors and ignition takes place because the compression in the cylinder is great enough to increase the temperature to the degree that the fuel will burn spontaneously when sprayed into the cylinder. This is a high compression ratio of about 16:1 compared to 8:1 for gasoline tractors and 4:1 for the tractors that used kerosene. The average of 53 diesel tractors used in the 1960 Nebraska tests was 16.3:1. Although high compression means harder starting and usually noisier operation, it makes it possible to make better use of the energy in the fuel.

The manufacturer has certain qualities in mind when designing a particular engine with a specific compression ratio. Fuel recommendations are made in relationship to these qualities. The farmer should follow the recommendations of the manufacturer when selecting diesel fuel. The driver should be ready to help with recommendations if the farmer does not know which fuel to use or if the farmer is using the wrong fuel. In selecting a diesel fuel, the following should be considered:

a. The grade of the fuel needed

b. The "Cetane" rating

c. The sulfur and water content

Individual producers previously determined their own grades of diesel fuel, although they have recently been standardized by the American Society for Testing Materials (ASTM) into the two grades which have desirable combinations of fuel properties.

Number One diesel fuel is better for cold weather because it has a lower viscosity which allows easier starting, and contains somewhat fewer chemical impurities. This is commonly abbreviated as No. 1-D.

Number Two diesel fuel is slightly cheaper than No. 1-D, supplies more energy per gallon, and has a higher viscosity. The higher viscosity provides better lubrication of the injectors, but also causes harder starting in cold weather. Number two fuel is abbreviated as No. 2-D.

The standards for these two fuels set the minimum "cetane rating," which for diesel fuels is roughly equivalent to, but not identical to octane rating for gasolines. These standards also provide maximum limits on impurities such as water and sulphur. Refineries usually provide a fuel which exceeds the minimum standards, which a farmer can purchase according to the recommendations in the operator's manual and be confident that he is using the best fuel for his tractor.

In diesel engines, "knocking" is caused by the fuel igniting too slowly. It should burn as soon as injected into the cylinder, and if there is much delay in burning, the fuel overloads the cylinder until it eventually burns with explosive force. This not only causes excessive noise but causes more wear on engine parts. This delayed burning in diesels is the exact opposite of the cause for knocking in gasoline tractors which is caused when the air-fuel mixture burns too rapidly, resulting in pre-ignition.

The octane rating system cannot be used for diesel fuels, since good quality diesel fuels provide for early spontaneous combustion, which is exactly opposite to what is wanted in good-quality gasoline. The rating scale for diesel fuel of 0 to 100 and the method of testing established by the ASTM is similar to that for gasoline, but different test-fuels are used, including cetane.

A cetane rating of from 40 to 60 is suitable for diesel tractor fuel and since ASTM specifies a minimum cetane rating of 40, both fuels fall within this range. The farm tractor manufacturer not only indicates the grade but also recommends a minimum cetane number. As with gasoline, the driver-salesman should know the cetane number of each of the diesel fuels he sells, and should be prepared to check that they are suitable for the particular make and model of tractor owned by the farmer.

Next to the cetane number, a farmer may want to know the amount of sulphur and water contaminants in the fuel. Sulphur burns in the combustion process and combines with moisture to form acids which can cause rapid wear and assist in the formation of deposits. These deposits occur in the cylinder and on pistons and rings. Water by itself may cause rust and interfere with the lubrication of the injectors. It collects on the filter screens and will freeze in cold weather. ASTM standards permit more sulphur in

No. 2-D fuel than No. 1-D, and farmers should see that harmful effects are counteracted by proper selection of lubricating oils.

See competency number III of this module.

3. Selecting Fuels for Two-Fuel Tractors

Tractors which start on gasoline and then switch to a lower-grade fuel for running are referred to as "two-fuel" tractors and were very popular at one time. They were less expensive to purchase than diesels and would use kerosene, distillate tractor fuel, number one fuel oil, and even furnace oil, but they have largely been discarded when worn out, or converted to use gasoline.

There are few tractors operating today on two fuels, therefore distributors rarely handle the variety of fuels that may be used for this purpose. Gasoline and kerosene should not be mixed in an attempt to provide a "grade" of fuel. Any given grade of farm tractor fuel is a chemical compound and not a physical mixture.

4. Selecting Fuels for LP-Gas Tractors

Liquified petroleum gas (abgreviated LP or LPG) must be kept under pressure at all times in order to keep it in a liquid form until introduced into the cylinder. This requirement for high pressure storage tanks at the terminal, and high pressure tank trucks for delivery usually causes LP-gas to be handled through different channels than gasoline or diesel fuels. The same high pressure tank can be used for crop drying and household heating or tractor fuel. The distributor of LP-gas also provides portable tanks on an exchange basis to provide gas heating for cooking, brooding, water heating, and other uses when natural gas is not available.

A tractor especially equipped to use LP-gas means a mounted pressure tank to replace the gasoline tank, and a compression ratio higher than 8.5:1. It is impossible to convert existing tractors to the use of LP, but this is usually done in a specialized shop rather than by the farmer. Modification is relatively expensive when the compression must be changed, but without this the economy of using LP-gas is improved.

Some distributors prefer to own the large 500 to 1000 gallon tanks rather than sell them to the farmer.

This permits better control and fewer operating or safety hazards. A modest "lease fee" is charged at the time of installation, which hardly covers the labor and fittings involved.

The cost for LP-gas decreases materially as the amount consumed per year increases. For this reason the farmer who uses LP-gas for tractor power usually uses it for crop drying, household heating, and other purposes. One company's rates in 1965 were:

1400 gallons or less per year---17¢ per gallon
1400 " to 2000 gallons----16¢ " "
2000 " to 3000 gallons----15¢ " "
Over 3000 per year--------------14¢ " "

While the use of LP-gas for farm tractors is increasing, the farmer must depend on the distributor for the quality of the product. The reliable distributor makes sure the product he secures from the refinery is relatively free from sulphur and other contaminants which might cause difficulties including regulator failures, filter plugging, and other problems.

LP-gas is no more dangerous than gasoline when properly handled. Distributors make every effort to properly instruct the farmer in operation of the tanks and equipment, especially in refilling operations. Storage tanks are all fitted with safety valves to permit burning rather than exploding in cases of improper handling. However, even these will not suffice for careless operation.

The following summary of fuels may be helpful:

Type of Fuel (Spark Ignited)	Octane Rating	Approximate Compression Ratios	Critical Points
Kerosene or No. 1 fuel oil	0-30	4:1	supplies lots of power-relatively high priced
Farm tractor fuel	35-70	4:7-1	replaces the old "distillate," "all fuel," "power fuel," etc.
Low grade gasoline	70-75	5-6:1	can be used, but poor economy for low compression engines using tractor fuel
Regular grade gasoline	80-93	7-8:5-1	standard for most tractors
Premium grade gasoline	95-105	9-10:1	suitable for automobiles
Liquid petroleum:			
Butane	95-100	7:8-1	limited use on farms because of higher cost; mostly used in the chemical industry
Propane	110-115	8:75-1	supplies economical power because of higher compression even though it contains less energy per gallon
Diesel fuel:	Cetane Number	Compression ratio	Critical Points
No. 1-D	40-60	14-20:1	use in winter for easier starting
No. 2-D	40-60	(average 16:1)	requires different lubrication oil because of more sulphur

5. Gasoline Additives

Materials added to fuels or lubricating oils which improve performance or increase economical yields at the refinery are referred to as "additives."

Major oil companies can produce a good gasoline with fair anti-knock properties through regular refining processes, but the yield would be so small that the gasoline would be too expensive. It is much cheaper to secure greater yields from crudes and at the same time create a higher performance fuel by the addition of additives. However, additives will be taken up under each product rather than being considered as a separate subject.

Small amounts of additives are used, and their cost is relatively cheap compared to their effect and the improved quality of the resulting product. All refineries use them and most gasoline sold today contains at least six or seven additives.

(Note to teachers: It is not necessary to go too deeply into the related chemistry of additives with high school classes, but post-high school students should know the names of the compounds and know a little of the chemical reactions involved.)

a. Anti-Knock Additives

The first additive used was tetraethyl lead (TEL) introduced in 1932 to combat the knocking of ordinary gasoline due to pre-ignition. It is still the major anti-knock additive, although today refineries use other lead compounds and mixtures. No one knows for sure how TEL and other lead compounds control or prevent knock, although extensive research is going on. We do know that gasolines are made up of many hydrocarbons with slightly different burning rates. When these hydrocarbons are compressed and heated in the presence of air, as in the cylinder, they react rapidly. When ignition takes place, the flame spreads rapidly in the combustion chamber and further compresses and heats the fuel-air mixture ahead of it. Some of the hydrocarbons in the unburned part of the gas may undergo chemical reactions prior to normal combustion. The products of these reactions may self-ignite and burn at a rate 5 to 25 times the normal combustion of the rest of the gas-oil mixture. This rapid burning sets up a high-frequency shock wave that produces the sharp metallic "knock."

A knocking engine gives less power with resulting poor fuel economy. Severe and continuous knock increases wear and life of valves, plugs, pistons and bearings.

Present evidence indicates that a fine dispersion of solid lead oxide or lead metal is what prevents or overcomes the knock by slowing down the reaction rate.

Tetra methyl lead (TML) increases the octane number of some modern gasolines more than TEL and does a better job of overcoming the knock resulting from fuel segregation and manifold lag. When this happens, the more volatile fractions with lower octane numbers fill one or more cylinders and "knock" while others receive charges with higher octane numbers and more anti-knock additives than are necessary. TML, being more volatile than TEL, tends to distribute itself more uniformly to all of the cylinders when mixed with gasoline. The process by which TML prevents knocking is probably the same as for TEL.

Mixed lead alkyls were developed to provide an additive intermediate between TEL and TML both in composition and volatility. This was accomplished by enabling TEL and TML to react in proper proportions and under proper conditions.

Custom blends or mixtures of TEL and TML are also available for providing any degree of volatility between TEL and TML.

The customer is more interested in the result of the anti-knock additive than its physical or chemical composition. The salesman should have some overall knowledge of the kinds of anti-knock additives and how they work, but the customer and the salesman must depend on the producer to use the proper additive in the proper amounts.

b. Scavenger Additives

It is a characteristic of additives that as soon as one is added to improve an existing condition, another must be added to counteract the original additive. For this reason, scavengers are added to leaded gasoline to remove the non-volatile combustion products resulting from the burning of the anti-knock additive. Ethylene dibromide and/or dichloride are added to change combustion products into forms which vaporize easily from the hot engine surfaces. This is a major reason why "white" gas is preferred for gasoline lanterns. Such scavengers are always included whenever a lead compound is used for anti-knock purposes.

c. Promoter Additives

Another additive to an additive is a complicated manganese compound which greatly improves the anti-knock characteristics of leaded gasoline when used in very small quantities. This manganese compound is used in most gasolines.

d. Deposit Modifier Additives

Deposits in the combustion chamber can cause pre-ignition by glowing at temperatures high enough to ignite the incoming fuel-air mixture. Phosphorus or boron is added to gasoline to change the deposits to forms which have both higher electrical resistance and more resistance to glow. The same phosphorus or boron additives prevent deposits on the spark plugs during light duty or low temperature operation of an engine. This results in cleaner spark plugs and more reliable performance.

e. Antioxidant Additives

Gum formation is caused by the oxidation of some of the unstable hydrocarbons in gasoline. This gum results in varnish-like deposits which clog fuel lines, carburetor jets, intake manifolds, and buildup on intake valve stems, causing them to stick. It is influenced by many factors, including the length of the storage period. Phenol compounds are used as antioxidants and are added to gasoline to retard this gum formation. Because the gum formation still occurs, but at a slower rate, gasoline should not be stored over six months.

f. Metal Deactivator Additives

Copper contamination results during gasoline manufacture and storage in small amounts and results in increased oxidation. This situation is overcome by adding small amounts of "chelating agents" which stabilize the copper compounds and overcome the effect of copper contamination.

g. Anti-Rust Additives

Hydrocarbon soluble compounds are used, which coat metal surfaces with a thin protective covering, and thus prevent water in the fuel from coming into direct contact with metal surfaces. These agents, usually fatty acids, inhibit rust and carburetor jet clogging. These additives also help to prevent carburetor icing and avoid buildup of deposits within the carburetor.

h. Anti-Icing Additives

Farmers usually blame ice in carburetors on water in the gasoline. This may happen when storage tanks are not properly handled to prevent accumulation of water due to condensation. However, it is frequently caused by the freezing of the water vapor in the air which is drawn into the carburetor independently of the moisture in the gasoline. This may happen when a cold motor is started with atmospheric conditions of above 65% relative humidity and a temperature of 30 to 50 degrees Fahrenheit. The fuel vaporizing in the carburetor creates a cooling effect which in turn causes the moisture in the air to condense and form ice in the carburetor. At idling speeds, ice can bridge the small gaps in the throttle mechanism thus cutting off the air supply and stalling the engine. Carburetor icing can also take place during constant speed operation resulting in "missing" because the mixture is too rich. This rich mixture occurs when the ice has built up in the venturi and acts as a choke.

Anti-icing agents may be either freezing point depressants or surface-active agents. Freezing point depressants act in the same manner as anti-freeze acts in radiators to prevent the formation of ice. They are usually alcohols or glycols. Surface-active agents coat the ice particles after they are formed and prevent them from sticking together. Phosphate compounds serve as surface-active agents and also as anti-rust agents.

i. Carburetor Detergent Additives

Deposits in the carburetor sometimes cause rough idling or stalling resulting in poor performance and poor fuel economy. These deposits result from the non-volative fuel components and contaminants from crankcase fumes being drawn in through the air cleaner. These deposits interfere with the normal flow of and with air-fuel ratios. Detergents are added to most fuels to prevent the buildup of deposits and reduce those already in place. The usual detergent additives are phosphate compounds which work because of their surface-active properties.

j. Upper Cylinder Lubricant Additives

A number of products were developed and are still sold at filling stations to prevent piston ring and valve sticking. These are usually unnecessary in today's gasolines which have these additives incorporated into them at the refinery. The upper cylinder lubricants are usually light mineral oils or naphenic distillates of low viscosity which function by dissolving the deposits and rinsing them out during engine operation.

k. Dye Additives

Dye is included in leaded fuel to identify the use of such fuel for motor fuel only and not for heating or cleaning purposes. They may also be added to promote sales appeal or identify the product or the grade of a product. All dyes are soluble in petroleum fuels, and vary in intensity according to the refiner's standard. They have nothing to do with the performance of a gasoline.

Some states require that gasoline sold for off-highway use be dyed a different color than that used by vehicles on the roads. In some states, misuse of the dye is a serious offense.

Suggested Teaching-Learning Activities

1. Give either an oral or written pre-test to determine how much knowledge the members of the class already have concerning tractor motor functioning and fuels. The questions should include fundamentals and nomenclature of internal combustion engines. The teacher can refer to modules of the course in Agricultural Machinery Occupations, particularly numbers 13, 14, and 15, if he has difficulty in developing a suitable list of key questions. It is vital that a salesman know at least as much about the mechanical functioning of the power equipment for which the fuel will be used as the farmer. Nothing will cause a loss of confidence faster than for a salesman to indicate his lack of knowledge by making an inaccurate or inappropriate remark.

2. Use class discussion to bring out the points indicated by the pre-test with particular emphasis on information a salesman should have to be of service to the farmer customers. The teacher should go as far as necessary to ensure that potential salesmen understand the meaning of

such terms and processes as catalytic cracking, anti-knock volatility and vapor lock, water or dirt contaminants, impurities, and "additives." This can be introduced under the heading placed on the chalkboard: "What should a driver-salesman know about selecting tractor fuels?"

3. Visit a refinery so the students can visualize the process which starts with crude oil, and is capable of producing so many products by the refining process with a high degree of flexibility. In place of this, visit or have brought to school a display of a major oil company, showing the variety of products available, and including samples.

4. Identify the type of fuel each member of the class uses in his home tractors by type, octane or cetane number and compression ratio. Amplify, if necessary, by including the information pertaining to their neighbors' tractors in order to have all types presented.

5. List on the chalkboard the types of fuel available from local distributors and assign individual students or pairs of students to secure the information needed to complete a chart similar to the one found on page 23.

6. Visit a laboratory equipped for determining octane numbers or cetane numbers and observe the testing process. Alternatively, try to get a representative of the laboratory to visit the school and demonstrate the testing process.

7. Role-playing can be used to bring out the relative advantages of one type of tractor fuel over another, with one person representing a farmer and another a salesman for each type of fuel.

8. Use a film or film strip to show the use of "additives" in gasoline or have a representative of a major oil company present this orally to the class, exhibiting samples of the materials used.

9. The suggested time allotment for this competency is:

Class instruction-------------	5	hours
Field trip or laboratory------	1	hours
Total------	6	hours

Suggested Instructional Materials and References

Instructional materials

1. "Selecting and Storing Tractor Fuels and Lubricants," color filmstrip, Southern Association of Agricultural Engineering and Vocational Agriculture, Athens, Georgia.

2. Films or filmstrips available from major oil companies.

3. Samples or charts available from major oil companies.

References

1. Selecting and Storing Tractor Fuels and Lubricants, Southern Association of Agricultural Engineering and Vocational Agriculture.

2. Motor Gasoline Additives and Their Functions, Ethyl Corporation of America, New York, New York.

3. Drower, Mezera, and Nast LP Gas Engine Fuel--"To Be Or Not To Be...That is the Question, International Harvester Company.

4. Publications from major oil companies.

Suggested Occupational Experiences

1. Working in any capacity that brings the student into contact with the different kinds of motor fuels and the people who buy or sell them. This may be at the terminal, riding with a driver-salesman, or in a retail filling station.

2. Working as a tractor operator preferably on a farm which has more than one tractor and uses more than one kind of fuel.

3. Working in a situation where liquid petroleum gas is used for brooding or crop drying.

II. To understand the proper storage facilties for tractor fuels on the farm

Teacher Preparation

Subject Matter Content

Ordinarily the salesperson will not be directly involved in installing storage facilities for tractor fuels. However, he plays an important part in (1) assisting and advising the farmer on proper location and installation and (2) in reporting to his supervisor such conditions as improper or unsafe installations and the need for maintenance of equipment. For these reasons, he should be as familiar with proper farm storage as the persons who do the actual installation. Some experience in working with storage installations would be excellent for a route man. The matter of proper storage facilities may arise when the salesman is developing new customers. He should be able to give positive answers concerning company policy in providing and maintaining storage facilities.

Most standard sizes for tanks for on-farm storage of tractor fuels are 150, 200, 300, 550, and 1,000 gallons and may be designed for above-ground or underground installation. The type the company will install will probably be determined by the normal delivery cycle, and the necessity for underground storage as a safety factor. Almost any farm can have a 300-gallon or less capacity, above-ground, gravity flow tank. Customers who use enough fuel on a monthly delivery schedule to justify a 300 or 550-gallon tank can have an above-ground tank mounted on skids equipped with an electric pump for filling. Such tanks are usually preferred to the gravity flow type as they are near the ground, which makes them less subject to upsetting when empty, and less conspicuous. However, they must be situated fairly close to a source of electricity.

Underground storage is usually preferred by farmers because of: (1) safety, (2) appearance, since only the low silhouette pump appears, (3) reduced losses due to evaporation, and (4) ability to place closer to buildings with safety. However, there are two minor disadvantages: (1) tanks must be hand-pumped periodically to remove water which has accumulated in the bottom and (2) while leaks are rare, they are harder to detect and much more difficult to repair or replace. Loss of fuel and slight contamination of a nearby well may go on for a long time.

In some areas pumping of the tank may be the supplier's responsibility. Farmers who need a 1,000 gallon tank usually choose between burying it because of its size, and having two 550 gallon tanks placed above-ground to provide more flexibility as to location.

Tanks are customarily leased to the customer by the company for a nominal fee to make the agreement legal. This amount sometimes is as little as $1.00. This lease is for the life of the tank, and permits the company to pick up and remove a tank whenever a customer ceases to use the product or pay his bills. Companies are understandably reluctant to install underground tanks until they are reasonably sure of customer volume, loyalty, and credit. In most states anything placed beneath the ground becomes an appurtenance and legally goes with the land when it is sold. In cases where a customer changes suppliers, the industry practice is for the new supplier to reimburse the previous one for the value of the tank based on the number of years it has been used. The original costs of the tanks are usually standardized throughout a given service area, and reference tables have been prepared so the previous supplier merely bills the new one for the depreciated value of the tank. However, if a farmer sells his farm and the new owner does not desire to use the storage tank for fuel storage, the company which installed it cannot come in and dig up the tank unless this is agreeable to the land owner. Even if agreeable, the company may not care to remove the tank because the cost involved may be more than the salvage value of the old tank.

Each state has laws concerning the storage of fuels, including the handling and use of each type of fuel. Driver-salesmen should become acquainted with state laws and regulations, not only for their own safety, but also to be able to advise their customers regarding safety and insurance. The state fire marshal is responsible for the enforcement of state laws concerning the manufacturing, storage, handling, sale, and transportation of fuels. Copies of the rules and regulations published should be secured to determine the responsibilities of the firm, the driver, the salesman, and the farmer for the safe handling and storage of fuels. These regulations will differ from state to state, but are usually based on the standards and codes established by the National Fire Protection Association or the National Board of Fire Underwriters. In general, state regulations will include the following items pertinent to farm storage:

1. Definition of flash point at which a petroleum liquid will give off flammable vapor. That is the minimum temperature in degrees Fahrenheit that the vapors given off will ignite when near an open flame.

2. Division of fuels into classes determined by flash point. Examples of these are:

Class I - flashpoint 20° F. or below--gasoline

Class II - flashpoint above 20° F. but below 70° F.--kerosene, No. 1 diesel, No. 1 fuel oil

Class III - flashpoint above 70° F.--No. 2 diesel, No. 2 fuel oil

3. Limits on the amounts of fuels which may be stored above-ground unless a special tank is provided. Usually this limit is 60 gallons or less, which allows the use of 55-gallon drums. While such drums may be stored outside, they may not be inter-connected or pumped under pressure. Under certain conditions, 55-gallon drums may be stored inside a building used solely for storage and located at least fifteen feet from any other building.

4. Limits on the distance of the site from buildings, haystacks, or other combustible structures. These limits vary from state to state. A generally-accepted safe distance for above-ground tanks of 60-550 gallon capacity is forty feet. For underground tanks regardless of capacity there should be a minimum of one foot between the foundation and the tank with the fuel pump located a minimum distance of fifteen feet from the building. This pump should be located so that no vehicle or equipment being filled will be closer than fifteen feet to a building.

5. Specifies the standards for above-ground containers of 60 to 550 gallons:

   a. 14 guage metal or heavier, single compartment welded or equivalent, made vapor-tight

   b. A filler opening which can be locked

   c. Vents with a free opening of 1½ inches to relieve any vacuum or pressure which may develop during normal operation or exposure to a fire

   d. Elevated containers for gravity discharge must have supports of adequate strength and stability. The bottom opening must have an internal safety valve for automatic shut-off in case of fire. This valve may also be operated manually (operates by means of a heat-releasing device). The delivery hose should be of approved design with a self-closing valve at the discharge end, which can be padlocked to its hanger to prevent tampering.

e. Skid tanks for pump discharge should be six inches off the ground and supported in a stable manner; equipped with an approved type of pump and hose capable of being padlocked to prevent tampering, and provided with an anti-siphoning device.

f. Containers should be conspicuously marked with the name of the contents and the notice FLAMMABLE--KEEP FIRE AND FLAME AWAY.

g. Above-ground containers of 60 to 550 gallon capacity should be spaced at least one diameter apart.

h. Tanks of 1,000 gallon capacity or more are usually placed underground except for LP-gas.

i. Underground tanks must have a minimum covering usually consisting of three feet of earth or eighteen inches of earth and six inches of reinforced concrete; they must be vented with a pipe not less than 1¼ inches in diameter which discharges in a generally upward direction not less than 12 feet above the filler opening. Vent pipes must be laid so they drain toward the tank without any sags or traps.

Arrangements should be made for filling an underground tank immediately after installation to prevent its buoyancy "floating" it upward out of the soil. Even after continued use it should never be entirely emptied except for cleaning, and then not for long periods of time. A six-inch layer of clean washed sand will provide a proper bed for an underground tank, and will cut down the corrosion if it is used to cover the entire surface of the tank and the underground, filler, and vent lines. Care should be exercised when installing underground tanks not to damage the rust-preventive protective coating.

Suction lines within tanks should not extend to the bottom; this prevents water accumulated from condensation from being pumped out with gasoline or fuel oil.

Both farmer and salesmen are interested in other aspects of gasoline storage not specified in laws and regulations. These include (1) control of losses through evaporation, (2) avoiding gum deposits, (3) protection from dirt and water, and (4) protection against theft.

1. Gasoline Storage

Not only are evaporation losses expensive, but they frequently cause starting difficulties. Gasoline which is lost to the air is of no value. Summer blends of gasoline do not evaporate as readily as those provided for winter use if the temperature is the same, because of different blending at the cracking plant. Summer blends held over to winter months will cause tractors to be hard to start because they are not so volatile. Winter fuel will cause hard starting in cold weather if held for several months. A general rule is that gasoline should never be held longer than six months in an above-ground vented tank.

The following methods may be used to prevent evaporation losses:

a. Installing tanks underground

b. Painting above-ground tanks white or aluminum to aid in reflection of the sun's rays

c. Installing a shade which protects from the direct rays of the sun and also cuts down on evaporation caused by the soil

d. Installing a pressure-vacuum relief valve in an above-ground tank if permitted by state regulations.

Pressure-vacuum relief valves may be installed in place of the standard vented cap, but the tank must be airtight for it to work properly. Such devices operate through a pressure valve which opens when the tank heats and a vacuum valve which opens during cooling. The pressure valve is forced open when a pressure of three pounds per square inch is reached because of heating and allows enough vapor to escape to maintain safety. The vacuum valve also aids in controlling evaporation by maintaining a constant inside pressure. One should never attempt to prevent evaporation by sealing the vent without installing a pressure-vacuum valve. It may blow up when heated, or collapse if sealed while hot, because of the vacuum which develops as it cools.

The percentage of loss by evaporation per month from above-ground tanks is approximately as follows:

a. Tanks painted red without protection of a pressure vacuum valve----------------------3.2%

b. Tanks painted white but without protection of valve--------------------------------2%

c. Tanks painted white and protected from sun and wind---------------------------------.8%

d. Tanks painted white, protected, and equipped with valve-------------------------.4%

Gum deposits result from oxidation when gasoline is stored for a long time. Most manufacturers put an inhibitor in the gasoline to retard gum deposits for six months to one year. The life of this inhibitor is reduced when the gasoline is exposed to sunlight and high temperature. Gum deposits can be avoided by not ordering more gasoline than will be consumed in about one month's time.

Moisture from condensation results from the variation of temperature around the above-ground storage tanks. Fresh warm air is "breathed" into the tank and may contain more moisture than it can hold when the temperature goes down. This excess moisture condenses on the inside of the tank and collects as water in the bottom. Gravity tanks must be so that this water will be held in the tank rather than being drained into the tractor. Suction lines in above-ground skid tanks should not allow pumping the tank dry which would suck up the moisture accumulated in the bottom. Water should be removed periodically from all tanks whether by draining or by using a hand pump. Never attempt to use the same pump for water removal that is used for the gasoline.

Dirt is avoided by using care when filling the tank, by keeping caps in place, and by careful fueling of the tractor.

2. Diesel and Tractor Fuel Storage

Evaporation in diesel fuel or any tractor fuel which is similar in volatility will not be a problem because its low volatility.

Dirt and water are more serious in diesel fuels than in gasoline because they interfere with the injector system. Any dirt, even the very fine particles, interferes with the moving parts of the injectors because of tolerances measured in millionths of an inch. Water causes corrosion even when present in small quantities, thus ruining the highly polished surfaces of the injector.

Water settles out of diesel fuel very slowly because both are about the same weight. Storing diesel fuel in two tanks and using each on alternate days will allow 48 hours for the water to settle out, resulting in little difficulty from moisture.

If it is not feasible to have two tanks, fill the fuel tank on the tractors before refilling the storage tank. If possible, allow the tank to settle 24 hours after filling, before refueling the diesel tractors. Never fill the tractor immediately after a diesel fuel tank is re-supplied as the filling action stirs up the water and dirt that may be present.

Careful distributors deliver a product which is relatively free from dirt. Most of the contamination comes from improper handling or storage on the farm. This happens when:

a. Open containers are used to transfer fuel rather than the proper kind of hose.

b. Diesel fuel is stored in a galvanized tank. While satisfactory for gasoline storage, the diesel fuel reacts with the zinc used in the galvanizing, reducing it to power.

c. Tanks formerly used for gasoline storage are used for diesel fuel. Fine rust and dirt particles which may have settled out of the gasoline and accumulated on the bottom, are picked up and held in suspension by the diesel fuel.

d. The suction pipe extends closer than 3" to 4" to the bottom, or the tank slopes toward the outlet valve so that dirt and water are picked up during the pumping action. In underground installations, water will accumulate if the suction pipe is not equipped with a foot valve to eliminate "drain-back." The difference in the temperature of the stored product and the fuel in the feed line may cause absorption from the ground moisture.

e. Failure to drain the tank to remove the accumulation of water and dirt in the bottom. Above-ground tanks should be drained at least twice a year and thoroughly cleaned with clean diesel fuel to rinse out the loose sediment. Draining once a year is usually sufficient for underground storage when a hand pump is used. Diesel fuel used in rinsing tanks may be set aside in a closed container for 24 hours to allow the dirt to settle out. The top portion can then be used for fuel purposes, but the remainder should be discarded.

Shading above-ground tanks is desirable to keep down the gum and varnish-forming tendencies as well as to reduce the effects of condensation. Gum inhibitors placed in diesel fuel by the refiner usually last about three months.

Diesel fuels may be stored up to three months without loss of quality so that diesel storage capacities may be larger than gasoline storage capacities, to take advantage of lower prices from off-seasons or price variations.

Diesel fuels are considered as Class II fuels because they are much safer than gasoline from the standpoint of flashpoint. However, there is ever-present danger from tractor filling operations. The same precautions in locating tanks should be taken as with gasoline. (See section II, number 4 of this unit.)

3. Storage for LP-Gas

LP-gas must be stored in pressure tanks. This presents some problems while eliminating others, since the gas is under pressure. There is no loss from evaporation, and chemical changes do not occur, therefore allowing the farmer to have large tanks and to keep fuel as long as he wishes. While underground storage is possible, it is better to have the tanks above ground so that leaks can be easily detected. A soapsuds solution applied at connections will indicate leaks, but never under any conditions try to use a flame to detect leaks.

The pressure tanks for LP-gas are more expensive than than those for liquid fuels, but this is a concern of the distributor rather than the farmer when fuel is provided on a loan or lease arrangment. Standards for LP-gas tanks have been set by the Underwriters Laboratories and anyone can easily tell whether or not they have been approved by looking for the distinctive label on the nameplate attached to the tank. This nameplate usually provides the following information: name of company, maximum allowable working pressure in psi at 650 degrees F., serial number, date built, surface area, length, outside diameter, head thickness, shell thickness, whether for above-ground or underground use, water capacity in gallons, and a statement as to the type of product which may be stored with the limit on the vapor pressure in psi at 100 degrees F.

LP-gas tanks must be sited not less than 50 feet from buildings and not less than 20 feet from storage tanks for other types of liquid fuels in order to comply with the National Board of Fire Underwriters standards or N.F.P.A. standards.

Great precautions must be taken with LP-gas tanks to avoid possible accidents at filling-time which damage the tank or fittings. Installing buffer posts will prevent vehicular damage to the tank, fittings, or hose. This is especially necessary if a tank is used to fill tractors.

Common tank sizes for LP-gas are 250, 500, and 1,000 gallons, but they should not be filled to more than 80% capacity. This will allow for expansion during hot days without exceeding the tank pressure limit. It is customary to allow about 25% more tank capacity for LP-gas than for gasoline and to refill not oftener than once a month.

Since the cost of LP-gas decreases with the amount used and since LP-gas is well suited for heating as well as for tractor fuel, it is usual for a farmer to use this fuel as much as possible. This includes uses for crop drying, brooding, water heating, household heating, and cooking. Making entirely new installations or converting old ones may be expensive for the farmer even though the distributor supplies tanks on a relatively cheap basis. The salesman should be in a position to advise the customer on installation and use, but in complicated situations the planning should be done by a more specialized person, usually the distributor. Rather than one large 1,000-gallon tank, it may be better to have two 500-gallon tanks. These may be placed so that one will serve for tractor refilling, milk house heating, and for crop drying, with the other serving the house for heating, hot water and perhaps brooding. Lines extending from large tanks are relatively expensive and must be properly installed to avoid leaks and sags since gas liquifies and collects in low places and may freeze in cold weather. If freezing occurs, two-stage regulation may be used in order to assure proper service. While there is no standard, it is common practice to add another tank if lines are longer than 200 feet from the main tank.

Unless the demand for LP-gas at some particular point justifies the expense of the line, it may be better to use a bottle which can be carried by one man. Such a bottle can be used for refilling a tractor which becomes empty in the field. Using two portable tanks would permit one to be replaced without interrupting the flow of gas. Farmers usually have to buy these portable tanks when they do their own refilling from a main tank which must be equipped for this purpose. Tanks are considered portable when mounted on a chassis which can be taken into the field for refueling tractors or other temporary locations. These are sometimes called skid tanks. When full tanks are provided on a replaceable basis by the distributor, there is usually no charge except for the gas. However, a farmer should always have one bottle on hand ready for use in emergencies. Farmers can easily determine the proper amount of gas to put into a bottle by placing it on a scale and cutting off the flow when 60 pounds is reached.

Storage tanks should be equipped with both a liquid filler hose and a vapor return hose. The latter allows the vapor accumulating in the top of the tractor tank to be saved and returned to the main tank during filling operations.

When properly handled, LP-gas is no more hazardous than gasoline. However, being under pressure and requiring many fittings where leaks can develop, it is extremely important that everyone who uses the system observe safety precautions, especially when making the connections. The new customer must be given a thorough orientation when the tanks and lines are installed, preferably by someone better qualified to do this than the laborer making the installation. The driver-salesman may do this if properly trained, unless the time required disrupts his delivery schedule. However, he should be responsible for observing and correcting any improper techniques practiced by the farmer. He should also report any situations to his superior which he thinks are hazardous or that may become hazardous.

All large LP-gas storage tanks have built-in safety relief devices which release gas to burn relatively harmlessly in case of fire, rather than exploding. In case of fires involving the tank, it is better to allow the contents to burn away through a limited opening rather than risk an explosion because of amateur handling. Special fire extinguisher equipment and instruction for handling emergencies should be provided before the tank is first filled.

Suggested Teaching-Learning Activities

Class discussion should be used to bring out the subject matter either prior to or during any of the teaching-learning activities listed below:

1. The relative advantages and disadvantages of above-ground and underground storage can be brought out in a discussion. Have students determine the type and capacity to use in their home situation and defend their choice. Many factors will be involved in the correct choices. The students should be able to identify the following advantages of above-ground tanks:

    a. They cost less to purchase.

    b. There is no danger of ground-water seeping into fuel.

    c. Leaks are easily detected.

    d. They are easily moved.

    The advantages for underground tanks should include the reasons that:

    a. Less fuel evaporation occurs

    b. Less condensation of water inside the tank occurs

    c. The gum-depositing tendency is slowed

    d. Fewer fire hazards exist

    e. Tanks may be placed closer to buildings

    f. Tanks are hidden and do not detract from the appearance of the farmstead

2. Ask the students to bring in lease agreements their parents or neighbors have for comparison purposes. Bring out the general aspects of a contract, including

the legal terms used and specific stipulations. Alternatively, the teacher can secure copies of blank lease agreements from several companies to serve the same purpose. He can also develop typical agreements with the class, using blank instruments.

3. Secure copies of the state laws and regulations pertaining to fuel storage and have the students pick out those items pertinent to farm storage. After assembling the list on the chalkboard, each student should record the key items in his notebook.

4. Ask the students to assume that they are salesmen. Then ask them to work in pairs and to prepare a listing of every item they should cover in discussing the farm storage of fuels with a customer. They should know the facts and figures for each type of storage without using references. These lists may be separate for (1) gasoline, (2) diesel fuel, (3) two-fuel tractors, and (4) LP-gas. They should cover evaporation losses, gum deposits, moisture and dirt, tank placement, tank cleaning, safety factors, and others from personal experience.

5. Role-play with students working in pairs in the following situations:

    a. A farmer presently using gasoline tractors wants to change to diesel and asks the salesman many questions about the new storage necessary, or the conversion of the old.

    b. A salesman for LP-gas approaches a farmer who is mildly interested in changing over from gasoline tractor fuel. Repeat the same situation for a farmer who is presently using diesel fuel.

    c. A farmer is getting ready to buy a crop dryer and approaches the LP-gas salesman to find out the cost for service and requirements for storage tanks.

6. A field trip to visit a farm where an underground storage tank is in the process of being installed for gasoline, and another farm where the installation is an above-ground tank for LP-gas.

7. A field trip to visit a farm which has an almost ideal setup for fuel storage and one which is not desirable. Have the students make notes to prepare a written or oral report analyzing the differences

and suggest ways for improving the storage situation on the poorer farm.

8. Have the students copy the information on the manufacturer's nameplates on the storage they have at home, or copy the nameplates from tanks observed on field trips. One or more students can be asked to copy the nameplates from tanks at a distributor. When this information is brought to class, each student should be asked to interpret the meaning of the various items and abbreviations.

9. A suitable test would be for the teacher to prepare a schematic layout for a hypothetical farmstead and have the students draw in the storage facilities needed by that farmer.

10. The suggested time allotment for this competency is:

Class instruction------------------------ 4 hours
Laboratory including field trips---------- 3 hours
(not including travel time)

Total---- 7 hours

Suggested Instructional Materials and References

Instructional materials

1. "Selecting and Storing Tractor Fuels and Lubricants," color filmstrip, Southern Association of Agricultural Engineering and Vocational Agriculture.

2. Films or filmstrips available from major oil companies.

References

1. Selecting and Storing Tractor Fuels and Lubricants, Southern Association of Agricultural Engineering and Vocational Agriculture.

2. Publication 1615 Installation of Underground Gasoline Storage Tanks and Piping at Service Stations, American Petroleum Institute.

3. Storage and Handling of Liquified Petroleum Gases, 1965, National Fire Protection Association Publication No. 58.

4. LP-Gas on the Farm, National LP-Gas Council.

Suggested Occupational Experiences

1. Working in a helper's capacity during the installation of tanks particularly for underground storage and for LP-gas. If work for wages is not possible, informal observation would be of some value.
2. Riding with a sales or service specialist calling on farmers desiring changes in storage facilities or wanting new installations.
3. Working on a farm and being involved in ordering, filling tractors, and observing the filling of storage tanks.
4. Working in a terminal and being involved in gauging tanks, and calculating shrink, as well as observing safety precautions.
5. Working in a filling station would be of some value for this competency.

III. To understand the proper selection of motor lubricating oils

Teacher Preparation

Note to teachers:

Module number 7 of the course in Agricultural Machinery Service Occupations covers lubrication in connection with agricultural machinery assembly. The teacher might well review this module in his preparation for the teaching of this competency and the following one on gear oils and greases. While there is some duplication of the subject matter content, an attempt has been made in this coverage to focus the presentation toward the human aspect of the deliveryman-farmer relationship rather than the machinery aspect.

Subject Matter Content

To develop his sales of oil, the salesman must first persuade the farmer to try out his product and then get him to order in six-month supply quantities for summer and winter service. He must know what lubricating oil is expected to do and hos his product accomplishes this. He should be able to assist the farmer even though the operator's manual has been lost. Distributors usually provide their salesmen with information for all makes and types of tractors.

Lubrication oil is used in the crankcase to:

1. Reduce the friction and wear between surfaces
2. Remove the heat caused by the friction of moving parts
3. Provide a seal against escaping gases
4. Keep the engine clean by keeping the carbon and sludge-forming materials in suspension so they will be removed when the oil is drained
5. Protect against rusting and action resulting from the combustion process

As tractor motors have advanced in complexity and performance, the oil refineries have had to keep pace by developing newer oils capable of doing many things not expected in earlier mechanized farming. In early days, "oil was oil" with no specifications or method of comparison provided. Today, the manufacturers have brought about many improvements in the product during the refining process. They have developed "additives" which make the current product much superior to any natural oil. These additives are chemical compounds not ordinarily found in petroleum, but used to improve the chemical and physical properties.

In selecting the proper crankcase oil, the farmer and the salesman both must consider (1) the viscosity as expressed by SAE numbers, and (2) the type of oil as expressed by American Petroleum Institute (API) letters. The viscosity is usually expressed by numbers such as SAE No. 30, commonly referred to as 30 "weight" oil. The type of oil is referred to API Service Classifications such as MM, MS, and DG.

Viscosity numbers were developed by the Society for Automotive Engineers (SAE) to guide the buyer in selecting the proper viscosity oil to use (in different engines) and under different winter and summer temperatures.

Using "too light" an oil will result in high oil consumption and may result in excessive heat because of the oil film being squeezed out from between the bearing surfaces. Using "too heavy" an oil will cause hard starting in cold weather and may cause excessive wear because it is difficult to circulate to moving parts such as remote piston rings. Oils differ greatly in viscosity or resistance to flow and in their ability to maintain a uniform viscosity under different temperature conditions. The same oil which was satisfactory for starting might become thin and lose its lubricating property when the crankcase temperature rises above 180 degrees.

A Saybolt viscometer can be used to determine the number of seconds required for a certain quantity of oil to pass through an opening of a certain size at a standard temperature. By establishing a standard, any oil can be classified as to viscosity. The SAE numbers originally begun at 5 and proceeded through 10, 20, 30, 40, and so on, up to 60 weight for lubricating oils. Oils bearing such identification are known as single viscosity oils.

For year-round tractor operation, it became necessary to have an oil which would flow readily for starting purposes in cold weather, but which retained its lubricating qualities at high temperatures. To identify these oils having those properties, the letter "W" was added to indicate their suitability for use in winter.

The single viscosity oils presently available are 5W, 10W, 20W, 20, 30, 40 and 50. Winter grade oils are satisfactory for summer use when the manufacturer specifies 5, 10 or 20 weight. Winter grade oils are ordinarily not made heavier than 20 weight since they are not needed in milder climates.

Advances in the refining process have resulted in oils which will retain their viscosity over a wider range of temperatures than single viscosity oils originally developed. Such oils are called "multi-viscosity" when they meet the SAE viscosity requirements for more than one number. By the use of additives, some oils can meet the specifications for as many as four single grade oils and are so marked on cans or labels.

Multi-viscosity grade oils cost more than single viscosity, but they may save the farmer money because:

1. They provide greater protection over a wider temperature range with less changing from one weight to another.
2. The tractor will start easier in cold weather with less danger of scoring cylinder walls and burning bearings during the first minute of operation. However, the oil will be heavy enough to stand up under normal operating temperatures.
3. There may be lower oil consumption because it is light enough for starting but will not thin too much at higher temperatures.
4. Only one oil needs to be stocked to serve several different engines.

As tractor engines improved, it became necessary to improve the oils used. This resulted in developing "Premium" and

"Heavy Duty" grades about 1947 and provided a guide in addition to the viscosity numbers. These oils contained additives but generally have been superceded by newer oils. The terms "Premium" and "Heavy Duty" should not be used as a buying guide now that API service classications and letters are used.

Beginning in 1952 and in current use are the API letter designations indicating the type of service for which an oil is designed. There are always two letters, and since the letter "W" is not used there is no confusion with winter viscosity oils. In selecting letters, the API attempted to pick those which would describe the oil and the type of service for which it was intended. The first letter is either "M" for Motor or "D" for Diesel to indicate the type of engine for which it is intended. The second letter is either L, M or S for spark ignition motor oils or G, M, or S for Diesel tractor oils. This second letter indicates the severity of service under which the engine operates. In this way there are six combinations of letters which cover all oils.

The possible combinations and the use designations are:

ML - Motor light

MM - Motor moderate

MS - Motor severe

DG - Diesel general

DM - Diesel moderate

DS - Diesel severe

The API has defined the service classifications as follows: (The key words have been underlined for emphasis.)

> "Service ML for spark-ignited engines used under light and favorable operating conditions, the engines having no special lubrication requirements and having no design characteristics sensitive to deposit formation."
>
> This is the least severe service condition and ML oils are no longer recommended for tractor or automobile use. In fact, most manufacturers warn against their use. The use of this quality of oil should never be recommended unless expressly specified by the manufacturer.
>
> "Service MM for spark-ignited engines used under moderate to severe operating conditions but presenting problems of

deposit or bearing corrosion control when crankcase temperatures are high."

Moderate operating conditions include prolonged operation at moderate speeds and heavy load or high speed operation during summer temperatures for only short periods of time. It does not include severe low engine temperature service such as stop-and-go driving or prolonged idling.

"Service MS for spark-ignited engines where there are unfavorable or severe operating conditions and where there are special lubrication requirements to control deposits, wear, or bearing corrosion control due to operating conditions or engine design or fuel characteristics."

Severe operating conditions are normal for tractors under continuous heavy load operation intermixed with stop-and-go driving and idling.

"Service DG for diesel engines in any operation where there are no severe requirements for the control of wear or deposits due to the characteristics of the fuel, lubricating oil, or engine design."

This oil is intended for the least severe of all diesel engine services under normal-rated loads, atmospheric temperature conditions and continuous or intermittant operations with fuels of low sulfur content and no special engine design requirements.

"Service DM for diesel engines operating under very severe conditions or using fuel of a type normally tending to promote deposits and wear but where there are design characteristics or operating conditions which make the engine either less sensitive to fuel effects or more sensitive to residues from lubrication oil."

This oil is intended for use with fuels high in sulfur but with less than 0.5% and where the engine design is critical to lubricating oil residues in the combustion chamber. It contains more detergent and oxidation-corrosion inhibitor additives than DG oils.

"Service DS for diesel engines operating under very severe conditions and having design characteristics or using fuel tending to produce excessive wear or deposits."

This oil is intended for use under the most severe operations including continuous heavy loads at high operating temperatures or intermittent operation at low temperatures and using fuels which are higher than 0.5% in sulfur and in engines with special design characterics sensitive to deposits. They contain the most additives, particularly detergents.

Manufacturers and distributors have distinctive brand names to promote sales and identify their different oils. Many of these oils are adequate for more than one service classification. For this reason it is desirable for the salesman to know the service classifications for brand names without having to refer to references. Most companies would prefer to have the customer buy on the basis of the brand name, rather than the service classification, but a well-informed farmer should buy on the basis of service classification regardless of brand name if there is a substantial difference in price. However, this assumes that he knows the meaning of the different service classifications. As would be expected, the ML oils are the cheapest while MS and DS oils are the most expensive. The wise farmer will compare prices for oils capable of equal services because he knows that the manufacturer would not place the API classification on his product unless it met the appropriate specifications. The prudent salesman will help the farmer compare prices to help him save money and also to make sure that he does not mistakenly buy oil unsuitable for the needs of his equipment.

Oils with higher service classifications may be used in place of lower grades. Unless the cost is much greater, farmers may prefer to buy one oil which will service all or most of his tractors and his automobile.

Modern tractors have design characteristics that must be matched with the oils used. To accomplish this, the manufacturer who is not in a position to recommend a specific company or brand name of oil, makes positive recommendations using the API service classifications. These recommendations are always found in operator's manuals and usually cover normal tractor operation and severe service requirements. These recommendations will also indicate the viscosity rating (SAE No.) which should be used under different temperature ranges.

It should be stressed that SAE numbers and API service classification letters are two different aspects of oils and should not be confused with each other. The former refers to the viscosity of oil and the API classification refers to the severity of the operating conditions. Each oil is identified by using them in combination. For every classification there is a range of viscosity numbers. Almost all major oil companies indicate both the SAE numbers and API service classifications on the cans or labels so that they can be readily seen. The SAE number is usually imprinted on the top of the cans. The API service classification may also appear on the top near the SAE number but often it is in small print on the sides of the cans or containers and smaller than the brand name.

The use of "additives" in present-day oils has improved them by creating qualities not attainable by refining methods alone, just as modern gasolines have been improved. Additives to oils are used (1) to prevent undesirable changes from taking place during its use in a tractor, (2) to improve the original properties of an oil, and (3) to impart new characteristics to an oil.

The salesman should know of the many chemicals which may be added to oils to improve them; but that the development and testing is quite difficult, costly, and time-consuming so that the number actually used is limited. However, when more than one additive is used it is necessary to consider compatability and balance. In some situations it may take two or three additives to bring about a single desired effect, but at the same time, one additive may contribute to more than one objective. In general, the more additives used, the higher quality the oil; however, this complicates the testing and increases the time and cost required for its development.

Motor oil additives have been developed over the years to solve specific engine problems or to improve the quality of the oil. Each time the manufacturer has improved the design of an internal combustion engine, the number and concentration of additives for the oil has increased. The first additive was used in 1932, and since that time many additives have been used.

The development of additives is a continuous process with new and better ones being used to meet the needs of improved engine design and the varying composition of crúde oils from different fields. It was originally thought that good motor oil could only be made from crudes with a parafinnic base, but it is now possible through the use of modern refining processes and the incorporation of additives to use many types of crude oils. This is one reason for the development of the API Service Classifications since what is desired is an oil which will perform under a specific set of circumstances regardless of the source of the base oil.

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*Note to teachers:

For high school classes it is probably sufficient to limit the discussion to the trade names of the additives and their general function. The sources of the additives and the chemical names and composition is probably more appropriate for post-high school classes. In general, the teacher should use his judgment of the degree to which this section should be brought out in class.

Additives in modern motor oils include:

1. Oxidation and corrosion inhibitors that lay down protective films on bearing surfaces to cut down the corrosion and prevent catalytic action of the metal promoting the oxidation of the oil. These additives usually are organic compounds of phosphorus and sulfur.

2. Detergent-dispersants keep the engines clean and prevent sludge or varnish deposits by holding the insoluble products of oil oxidation in suspension. Sludge and deposits are then removed as the oil is drained. All of these organic soap additives function as true detergents with some neutralizing acids and consequently reducing wear; and others combatting low temperature sludge.

3. Viscosity index improvers are used to increase the viscosity index (VI) which indicates an oil's resistance to change in viscosity as the temperature changes. A VI of 100 to 104 is desirable and the number can be secured from a VI alignment chart for those who desire to know. Organic compounds (polymers) with extremely high viscosities are used for these additives.

4. Wear-reducers are necessary because the extreme pressure (EP) of certain engine parts exceeds the lubricating load-carrying capacity ability of natural oil. Cam and tappets may operate under pressures exceeding 100,000 pounds psi. These additives are sometimes termed anti-wear agents or oiliness agents, and are also organic compounds but contain chlorine, in addition to sulfur and phosphorus plus zinc or lead. While it is not exactly known how these EP agents function, it is believed that they react chemically with the metal bearing surfaces to form new compounds which have improved friction properties.

   Certain animal and vegetable oils (oiliness agents) when added to the base oils reduce the friction between moving parts by changing the friction characteristics of the oil itself rather than reacting chemically with the bearing metal.

5. Rust preventatives have been discussed under gasoline additives, and function in the same way. Many are multi-purpose, as for gasoline.

6. Pour point depressants make it possible for oils to flow at lower temperatures, probably by coating the wax crystals with a thin film as they form when the

temperature is reduced. This film separates the crystals and prevents coagulation. The same additives used for VI improvers may also serve as pour point depressants and are effective in very small concentrations.

7. Anti-foam agents prevent excessive foaming when the oil is mixed with blow-by gases and air drawn in through the breather system. Foaming may cause vapor locking in the oil pump or reduce the amount of lubricating oil available at some critical point. It may also cause an incorrect reading of the oil level in the sump. Anti-foam agents are primarily silicone polymers or alcohols and only trace amounts are needed.

8. As in gasoline, dyes are used essentially to identify the product and promote its use through eye-appeal.

"Ashless" additives differ from conventional ones since they do not contain metallic compounds which tend to form engine deposits. They are presently available for ashless dispersants, ashless anti-rust agents, and ashless antioxidants. Oils with ashless additives have an application to heavy tractor operations to combat pre-ignition and reduce both the octane requirements and sludge deposits in light-duty vehicles.

The higher the viscosity index and the more severe the API service classification, the greater the total additive content. Some MS grade multi-viscosity oils contain as much as 20% additives by volume. Three additives are essential. The additive content of MS oils is approximately as follows:

Viscosity index (VI) improver	4.5% - 12%
Detergent-dispersant	3.0 - 6.5
Oxidation-corrosion inhibitor	0.5 - 1.5

Other additives, although in very small quantities, are necessary because their contribution to performance is very high in proportion to their concentration. When detergent oils first became available there was apprehension about their use in old motors, for fear that the dislodged deposits would clog oil lines. These can be used safely, and even gradual changeover is no longer necessary.

The salesman should be informed that oil companies test their newly developed oils for compatability with other oils of their own make and with those of competitors. This is to insure that the additives used will not interact unfavorably. A responsible oil company will not use an additive until and unless it can be blended in a way that will make it compatible with other brands. However, a selling point is for the customer to stick with the same brand, and most oil companies will not guarantee oils to give their best service when mixed with other brands.

Oils wear out in quality even though they are still present in sufficient quantity. This is true for the additives as well as the base oil. Hence, the necessity for changing oils as well as filters. The latter may remove solid material until its capacity is reached, but it cannot improve the liquid portion.

As with gasoline, additives can be purchased separately to add or supplement those already placed in an oil. These are usually sold to accomplish some special purpose such as improving valve lifter action or temporarily stopping the rattle of loose connecting bearings. These should not be used when the cost is excessive or if they are used in lieu of buying good oil in the first place.

Manufacturers always recommend changing oils at periodic intervals, but fortunately some farmers don't follow this practice. Some farmers never change the oil, particularly in old tractors. Others change the oil only when they change the oil filters. The salesman can increase his sales volume, and perhaps save the farmer money, by inducing him to change oil more frequently. Casual conversation when filling the fuel tank might lead to an order for a six month's supply. The advantage to the farmer in ordering a six month's supply is lower cost.

Suggested Teaching-Learning Activities

1. Students may have previously had varied experience with lubricating oils, so a pre-test would be in order to indicate which aspects of the subject matter content to stress.

2. When introducing this competency, pass empty cans of different brands and API classifications around the class and raise the question, "Which oil would you use?"

3. Class discussion can be used to insure understanding concerning: Why use a lubricating oil? What constitutes a good motor oil? What are SAE numbers and API service classifications, and of what value is this information to the farmer and the driver-salesman? What is meant by "additives" and why are they added to oils? Historical aspects of the development of modern oils will develop interest when interspersed with the other points of the subject matter.

4. Special individual reports from students with specific interests will hold interest, but may be time-consuming.

5. Have the students bring the operator's manuals for their home tractor to school and each interpret orally the manufacturer's recommendation on lubricating oils. Alternatively, exchange the manuals so the students will be unfamiliar with the one they will interpret. The teacher might secure old manuals or other literature from tractor manufacturers to augment those brought from home.

6. Use role-playing to bring out the pertinent points of viscosity numbers and service classifications, between a farmer and a driver-salesman who is supposed to be able to answer questions. Also bring out the significant points for additives using different pairs of students.

7. Have the students check the labels on the cans of oil they use at home and report on the SAE number and API service letters they find. Have each student explain the meaning to the rest of the class.

8. Invite an oil company representative as a resource person to explain testing of oils, determining what additives are used, and the blending process. It may be possible to arrange a field trip if an oil refinery or laboratory is close.

9. The teacher can improvise a Saybolt viscometer which will illustrate to the class that oils do differ in viscosity one from another at the same temperature and within themselves at different temperatures. See page 32 of Tractor Fuels and Lubricants.

10. List the headings on the chalkboard as indicated on the following page, and have the students provide the information under them for each service classification.

API Class	Type of Operation	Remarks or Critical Points
ML		
MM		
MS	(Note to teacher: See page 36 of *Tractor Fuels and Lubricants*.)	
DG		
DM		
DS		

11. Have students secure the prices in various size containers for all the brands of oil available through a single distributor from each of the firms doing business in the school service area. Place these on the chalkboard in tabular form with the service classifications along the top, and brands along the left-hand sides and the prices in the body. Challenge the students to compare these prices to determine whether there are marked discrepancies between the costs of the brand names of a single distributor. Complete the chart for one distributor before going to another. Students should be able to pick out the best buys of any given service classification.

12. The suggested time allotment for this competency is:

Class instruction--------------	7	hours
Laboratory instruction---------	1	hours
Total--	8	hours

Suggested Instructional Materials and References

Instructional material

"Selecting and Storing Tractor Fuels and Lubricants," color filmstrip, 134 frames, Southern Association of Engineering and Vocational Agriculture, Athens, Georgia, 1964, 48 pages. Price: $1.25.

References

1. *Tractor Fuels and Lubricants* (Selecting and Storing), Southern Association of Agricultural Engineering and Vocational Agriculture, Athens, Georgia, 1964, 48 pages. Price: $1.25.

2. Agricultural Machinery Assembly and Lubrication, Module No. 7 of course in Agricultural Machinery--Service Occupations, Center for Vocational and Technical Education, The Ohio State University, 1965.

3. Lubricating Oil Classifications, Technical Notes Series, The Ethyl Corporation of America, New York, New York.

4. Motor Oil Additives and their Functions, Technical Notes Series, The Ethyl Corporation of America, New York, New York.

5. Publication 1509A, Classification of Internal Combustion Engine Service.

6. Publication 1950, Know Your Oil, American Petroleum Institute.

7. Publication 1535, Buy on Performance, American Petroleum Institute.

8. The ABC's of Lubrication, Ashland Oil and Refining Company, Ashland, Kentucky.

9. Publications and illustrative materials of major oil companies usually obtainable through local distributors.

10. Kahil, P. Additives in Lubricants, SAE Journal, September, 1962, pp. 179-186.

Suggested Occupational Experiences

1. Working in a farm supply store where lubricating oils are sold over the counter.

2. Riding with a driver-salesman calling on farmers at the time they order six-month supplies of oils. This probably would be a non-paying situation.

3. Working on a farm or at a trucking company and be responsible for checking, adding and changing oils.

4. Working around terminals and helping to fill orders for oils.

5. Any kind of work around filling stations which brings the attendant in contact with the selection, qualities and uses of the different lines of lubricating oils.

6. Working in an oil refinery or testing laboratory would be the most desirable occupational experience for students with a keen interest in oils, even on an unskilled labor basis, but probably not possible except for schools located close to such installations.

IV. To understand the selection of gear oils, lubricating greases and hydraulic oils

Teacher Preparation

Note to teachers: The grouping of these products is somewhat arbitrary since they are essentially three different products used for three entirely different purposes. However, from the point of view of a salesman, they logically fall together as he normally considers all of them at the same time. Gear oils and greases are considered under Module 7, "Agricultural Machinery Assembly and Lubrication." Hydraulic oils are considered under Module 9, "Hydraulics Power Transfer Systems" in the course in Agricultural Machinery Service Occupations.

Subject Matter Content

In trade circles, lubricating oil and motor oil are synonymous, but this product more accurately should be described as crankcase oil. Originally, lubricants used in transmissions and differentials were referred to as greases because they more nearly resembled the greases used in wheel bearings than they resembled crankcase oils. The greases and heavy lubricants available at that time were satisfactory for early tractors, since they had large gears and poor seals.

Tractors today use lighter-weight lubricants which resemble crankcase oils, except for heavier viscosity and the use of different additives. These lighter-weight lubricants are necessary because the greatly increased tooth pressure and the increased wiping action associated with smaller gear sizes tends to remove the oil layer separating the gear surfaces as they mesh. Modern seals have no difficulty in retaining the oil. Practically every tractor manufacturer recommends a gear oil for transmission and differential use rather than a grease, and some indicate that the heavier weights of crankcase oil may be used.

Greases which are properly referred to as lubricating greases, continue to be used for wheel bearings and other moving parts not really enclosed in oil-tight compartments. Transmission and differentials are examples of this. Like lubricating oils, the lubricating greases have improved in quality.

The major difference between an oil and a grease is in its physical properties rather than its chemical properties. Grease is defined as "a solid to semi-solid product of a thickening agent in a liquid lubricant; other ingredients imparting special properties may be included."* Although these other ingredients are essentially the same as for oils, they differ in selection and proportion.

Greases may be made synthetically as well as from natural petroleum. The function of all lubricating oils and greases, whether natural or synthetic, is to reduce friction and wear by preventing metal-to-metal contact of moving parts.

1. Gear Oils

In selecting the proper gear oil, the user must consider the viscosity and the service conditions. To avoid confusion, the SAE have designated a higher series of numbers to indicate the viscosity standards for gear oils. The series for gear oils is from 80 to 140. However, these are not projections from those used for crankcase oils, and there is some overlapping. For example, SAE 80 gear oil has the same viscosity as SAE 20-30 crankcase oil and SAE 90 gear oil is similar to SAE 40-50 crankcase oil.

Service classifications for gear oils have been established by the American Petroleum Institute. They are similar to those established for crankcase oils. To avoid confusion they are referred to as "types" of service rather than "classes" of service. There are four types, and they are identified by names rather than by letter combinations. Farmers are usually concerned with only two of these types, "regular" and "multi-purpose," and these are the ones the salesman should know most about. The entire classification is indicated below for familiarization purposes:

a. Regular-type gear lubricant--A straight mineral gear oil used where tooth pressure and gear speeds are relatively low. Used in many farm tractors when recommended by the manufacturer.

b. Worm-type lubricant--not used in farm tractors

c. Mild-type extreme pressure (EP) gear lubricant--usually contains antioxidant and anti-foam additives plus additives to reduce friction under heavy loads. Recommended for only a few farm tractors.

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* The ABC's of Lubrication, National Lubricating Grease Institute.

d. Multi-purpose type gear lubricant--has more load-carrying ability than mild-type EP and is suitable for the most severe service conditions. It is commonly recommended for farm tractor transmissions and differentials and is frequently identified as GL 4 gear oil.

As with crankcase oils, the farmer should follow the manufacturers' recommendations on gear lubricants. The gear oil type has been selected because the manufacturer knows that it will provide the best lubrication for the type of gears and conditions under which they operate. This applies to both viscosity and service types.

Some tractor manufacturers make recommendations in terms of the Military Specifications Numbers (MIL-1----) rather than API service classification types. Oil companies usually provide tables equating the Military Specification Numbers with the API classifications. Occasionally these are valuable in talking with farmers about their lubrication problems and needs.

Gear oil has the proper viscosity when it has body enough to hold the moving surfaces apart so that there is no metal-to-metal contact. When too heavy a gear oil is used, the engine power is wasted, gears may be hard to shift, and in cold weather the oil may "channel" and provide little or no lubrication. Too light a gear oil causes rapid wear because the high points on gears come into direct contact or those gears operating in an oil bath do not pick up enough oil to carry to the next gear.

Gear oils also contain additives similar to crankcase oil, although they usually differ in number and content. These include antioxidants, rust preventatives, and foam inhibitors. Most important of all additives for modern tractors are those which develop a coating on the gear teeth protecting the metal from "welding" at high temperatures.

The terms "welding" and "spalling" frequently are used in describing bearing wear. When pressure and heat are great enough, thin metal contacts can actually "stick" or "weld" together. The forward movement of turning gears usually prevents a complete weld, but excessive wear takes place. This wear may be hard to detect with the unaided eye, but when very small pieces of metal come off, the effect is known as "spalling" and can be observed visually.

Special gear oils not covered in the API types must be used with some types of tractors, particularly those where the oil used in the hydraulic system is supplied from the transmission case. Occasionally, tractor makes specify a special additive to be used along with a standard gear oil which already contains additives. Tractor dealers normally stock these special oils and additives, and it may be better to direct the farmer to the tractor dealer in such cases. While all standard brands of gear oils are compatible, it is usually better not to mix them as less benefit from the additives may result. Gear oils, without any or fewer detergents, will reduce the detergent action of the entire transmission case when a little is added at a time.

2. Lubricating Greases

Unlike fuels and oils, there has been little standardization in lubricating greases. The National Lubricating Grease Institute of Kansas City has been working in this field, and while some progress has been made, there is nothing comparable to SAE numbers or API letters and type names. Without these, it is difficult for farm equipment manufacturers to make positive recommendations in terms which can be easily followed.

Possibly because of this lack of standardization, operator's manuals are not nearly as specific concerning the kind of grease to use as they are for oils and motor fuels. The farm equipment manufacturers do indicate where the grease is to be used, such as "ball and roller bearing grease," "wheel bearing grease," or "water pump grease." Formerly, it has been necessary for a farmer to have on hand three different kinds of greases for the chassis, for wheel bearings, and for the water pump. At times, such greases have been described as "No. 1 and No. 2 pressure gun grease," "all purpose grease," or "multi-purpose grease." Improvements in grease manufacture have resulted in a multi-purpose grease superior to and not to be confused with the old "multiple purpose" or "all purpose grease." Experiments have proved that this grease is satisfactory for every purpose on farm tractors and machinery. This eliminates confusion as to which type of grease to use, since only one needs to be stocked.

A good multi-purpose grease must exhibit the following characteristics: (1) pumpability when cold and over a wide range in temperatures, (2) suitability at temperatures as high as 150-160° F., (3) suitability for plain bearings, (4) suitability for high speed anti-friction bearings, (5) maintenance of the physical consistency and not softening or leaking out of bearings but excluding dirt and water, (6) prevention of rust, and most of all, (7) reduction of friction.

Manufacturers make several different grades or consistencies of greases for use in different geographical areas. Usually, only the one with the proper consistency for a given locality is stocked.

Salesmen should caution farmers about adding or mixing new multi-purpose grease to wheel bearings containing ordinary greases, as they are not physically compatible. This is particularly true when multi-purpose grease containing lithium soap follows ordinary lime soap grease. The proper procedure is to clean out all of the old grease from bearings and repack with the new. The old grease will squeeze out the new grease when used together in ordinary grease fittings.

Modern grease manufacture is quite complicated, but in general, only two types are manufactured, one using metallic soaps with a lubricating oil base and the other using inorganic gels as thickening agents in a natural or synthetic lubricating fluid.

Metallic soaps may be compounds of calcium, aluminum, sodium, barium, and lithium. Many claims are made for the advantages of various greases made from the different metallic soaps with lithium and barium enjoying popularity at the present time. However, good multi-purpose grease can be made from any of the metallic soaps by reliable manufacturers, and the fact that the company guarantees its product is more important than the exact ingredients used.

Formulation and testing of lubricating greases is a specialized function of the lubrication engineer. This may be of interest in a post-high school course. Some of the tests are:

a. Penetration and shear stability to determine the consistency (hardness or softness)

b. Dropping point to determine the temperature at which a grease becomes soft or fluid enough to flow

c. The shell-roller test to determine shear stability (resistance or breakdown under operating conditions)

d. Water resistance test to insure suitability under humid conditions and proximity to water

e. Extreme pressure test to determine the film strength under EP

f. Viscosity tests performed on the base oils rather than the finished greases to determine the suitability for use in greases

g. Wheel bearing test to measure the leakage of a lubricant from the hub, and any tendency of the grease to form varnish-like deposits on the bearing

The method of grease manufacture and the selection of ingredients is determined by each manufacturing firm. The reliable manufacturer selects and combines the metallic soaps or thickening agents to make a product which will stand up in a highly competitive field. A manufacturer may play up the use of a particular material by name to provide an advertising advantage.

There is no clear-cut advantage of non-soap greases over those made from soap, and good multi-purpose grease can be made from either type of material.

a. Non-soap thickened greases have no dropping (melting) point and are widely used as high temperature lubricants. However, the base oils will deteriorate, and the usual regular lubrication schedule should be maintained. This will avoid the formation of a thick, sticky, or hard granular mass possessing few lubricating qualities.

b. Non-soap greases have low temperature and pumpability characteristics when compared with the lithium greases which they may resemble in appearance.

c. Non-soap greases do not "wet" the bearing surfaces as is necessary for good lubrication and this is their chief drawback. Additives correct this to some degree although this remains their main drawback.

d. Non-soap greases have only fair mechanical or shear stability. This characteristic is undesirable for grease used for bearings running at high temperatures. Their stability is also rather poor in storage.

Synthetic lubricating fluids are used in place of petroleum oils to meet special requirements such as in jet engines, but these fluids are too expensive for use with farm machinery.

Additives are used in grease manufacture, but to a lesser extent than for oils or gasolines. The following are some inhibitors used in greases and their use:

a. Oxidation inhibitors especially prolong the life of a grease placed in storage and used for pre-greased bearings. When bearing temperatures reach 275 degrees F., the heat dissipates the oxidation inhibitors so there is little merit in using them for other than preservative values.

b. Extreme pressure (EP) additives are used in the better quality greases and function in the same manner as for oil.

c. Rust or corrosion inhibitors are necessary in non-soap greases and to a lesser extent for soap-based greases, depending on the raw materials used.

d. "String" agents are occasionally used to provide additional adhesives, but are not ordinarily found in multi-purpose grease. Greases containing such agents tend to be hard to pump at low temperatures.

e. Solid lubricants or "fillers" are added to greases to protect against metal-to-metal contact when the lubricating material is squeezed away under very heavy loads or shock loads. They also help to fill in the depressions present on rough bearings. Graphite and molybdenum disulfide are the most commonly used solid lubricants, however the latter is too expensive for multi-purpose greases.

3. Hydraulic Oils

These oils are especially blended for use in the hydraulic implement control system and in the power steering mechanism. Some manufacturers use the same oils to operate these systems as for crankcases and gear oils. The manufacturer's operator manuals list recommendations for both viscosity and oil type. These recommendations should be closely followed to avoid trouble, as the hydraulic oil must be matched to the hydraulic system design.

Hydraulic oil which is too heavy may cause excessive heating and thus increase oil oxidation. This increases its viscosity and causes gummy deposits to form on the pump surfaces and heavy sludge to settle in the low parts of the system. Using oil which is too light may cause loss of fluid through leakage. Oils of the wrong type tend to cause rubber seals to swell and deteriorate.

The additive usually placed in hydraulic oils are (1) antioxidants to keep oil from thickening, (2) rust and corrosion inhibitors, (3) anti-foaming additives, and (4) mild EP materials to prevent rapid wear of hydraulic pumps.

Storage for lubricants is relatively simple compared to that of gasoline and heating oil. All that is necessary is that they be kept free from dirt, moisture, and excessive heat. Manufacturers provide sealed containers in various sizes and a suitable size should be used to help prevent contamination and should be specified so that the contents will be used before the antioxidation inhibitor has lost its effectiveness. Greases in cartridge form may be desirable, as there is little chance for contamination. However, cartridges may be practical only for consumers of relatively small amounts of grease. Salesmen should note the manner in which oils and greases are stored, and tactfully suggest improved ways of storage. If canned oil is used, he can suggest keeping the tapper-funnel in a screw-top quart jar when not in use. Oil measures for transferring from bulk containers should be kept as dirt-free as physically possible.

Suggested Teaching-Learning Activities

The separation of gear oils, greases and hydraulic oil from the previous competency embracing crankcase oil was, as stated before, done largely because they are separate in the minds of the customer and may require a different sales approach. However, the teaching-learning activities suggested for the previous competency on lubricating oil will apply equally well to gear oils. For this reason, they will not be repeated in this competency. There may have to be some improvisation where there are no API classifications as in the case of greases, particularly in price comparisons.

The suggested time allotment for this competency is:

Class instruction------------------ 3 hours

Laboratory instruction would be included with crankcase oils.

A field trip to a grease manufacturing plant or laboratory would be valuable if within driving distance.

Total class instruction------------ 4 hours

Suggested Instructional Materials and References

References

1. The ABC's of Lubrication, Ashland Oil and Refining Company. (Note: This reference contains a large number of excellent illustrations suitable for class use with an overhead projector. The ones on testing procedure and manufacturing process for greases will suffice if a trip to a plant or laboratory is not possible. Others include: types of bearings, gears, ball and socket joints, etc., and their lubrication. The illustrations on wheel bearing troubles and repacking procedure are quite complete and informative.)

2. Agricultural Machinery Assembly and Lubrication, Module number 7 of course in Agricultural Machinery--Service Occupations, Center for Vocational and Technical Education, The Ohio State University.

3. Glossary of Terms, relating to the lubricating grease industry---National Lubricating Grease Institute.

4. Kahil, P. Additives in Lubricants, SAE Journal, September, 1962, pp. 179-186.

5. Lubricating Oil Classifications, Technical Notes Series, The Ethyl Corporation of America.

6. Sauter, N. A. Modern Farm Machines Need Modern Greases, Agriculture Engineering Journal, 1956.

7. Tractor Fuels and Lubricants (Selecting and Storing), Southern Association of Engineering and Vocational Agriculture, Athens, Georgia.

8. Publications and illustrative materials of major oil companies, usually obtainable through local distributors.

Suggested Occupational Experiences

1. Working in a grease manufacturing establishment or testing laboratory would be a very good occupational experience.

2. Riding with a route driver who can explain greases to his customers. This would probably be a non-paying situation.

3. Working on a farm with responsibilities for the checking and changing of gear oils, filling and operation of pressure grease guns, and daily lubrication of equipment.

4. Working in terminals or warehouses storing greases and being responsible for filling orders.

5. Work at filling stations which brings the attendant in contact with the different kinds of gear oils and greases and their application to lubricating problems. Lubricating passenger cars will not contribute much to development of this competency.

V. To understand the proper selection, delivery, and storage of heating oils (This competency is best suited to post-high school courses.)

Teacher Preparation

Subject Matter Content

Tractor fuel deliveries reach their peak during the summer months. Without the opportunity to deliver heating oil during the winter months, a driver-salesman would have his work load and income fluctuate with the seasons of the year. The same refineries make heating oil and tractor fuel; the same trucks can be used to deliver both, and the same driver-salesman can contact the same customers. In actual practice the volume of heating oil delivered on a year-round basis may exceed that of tractor fuel for many rural areas. This is because many suburban homes do not have tractors or other power equipment. Since driver-salesmen usually receive incentive payments based on gallons delivered, it is to their advantage to increase their volume of heating oil as well as tractor fuel.

Some tank trucks can carry more than one type of fuel on the same load. Because of compartment construction, these trucks may carry all gasoline in the summer and all heating oil in the winter or both of them at the same time when indicated by the seasonal demand. Care must be exercised to prevent mixing, particularly to prevent the more volatile and dangerous tractor fuels from mixing with heating oil. Gas mixed in with fuel oil would be very dangerous. To avoid this, some tank trucks have two inner walls between compartments and separate pumps. The double inner walls prevent mixing if one springs an undetected leak. The two separate pumps and delivery hoses make accidental mixing impossible. Separate delivery hoses are important, because delivery hoses may not be drained between stops.

It is absolutely necessary to remove thoroughly the liquid contents and also the fumes from a tank or compartment before using it for another kind of fuel. This is accomplished by thorough washing and may be performed by a specialized person other than the driver-salesman. If the deliveryman is assigned this duty, he must be very careful to follow the standard instructions.

The petroleum manager or dispatcher usually determines when a truck will be used for gasoline, heating oil, or part of each. He would prefer solid loads and regular delivery schedules but will use combined loads when the distance between stops and the size of off-loads becomes too small. There is an advantage in having the same driver service a route since he knows the customers and they know him. If this is not possible, the dispatcher must weigh the advantages of delivering solid loads with different drivers over that of hauling combined loads by the same driver. He must also determine when and how to provide the best service with the greatest economy. A driver-salesman should be aware of what the problems are and make suggestions when appropriate.

The selection of the proper heating oil is a relatively simple decision. Home heating appliances are built for either No. 1 or No. 2 fuel oil. No. 1 fuel oil, which is about the same consistency as kerosene, is more volatile and costs slightly more than No. 2 fuel oil. It is used primarily in "pot-type" furnaces and heaters or stoves where the fuel must be volatile enough to support its own combustion. No. 2 fuel oil makes up the largest volume of sales for heating purposes and is used in "gun" or nozzle-type burners. A spark is needed to ignite the fuel, because it will not support its own combustion. There is actually more potential heat per gallon in the No. 2 fuel oil, but the No. 1 oil is cleaner and contains fewer impurities. These impurities may clog burners when No. 2 is used in burners designed for No. 1 heating oil.

This is another situation where a deliveryman should set up a schedule to reduce the number of stops while maintaining each customer's supply.

Delivery problems are the same as for tractor fuel, with the addition of two minor and one major problem. The minor ones are: (1) the small capacity of home storage tanks for heating oil, and (2) the longer hose needed because of the off-driveway location of many storage tanks. The major one is the variation in the weather conditions, particularly temperature.

Most trucks have 150 feet of hose on self-winding reels mounted on the trucks, and if the storage tank is too far away it will take another section of hose. Storage tanks situated in basements may be limited in size. However, 275 gallon heating oil tanks may be used in pairs above ground with inter-connections that allow 550 gallons capacity. Monthly refilling is usually adequate for the average rural home. The usual underground tank size is 500 gallons.

The problem of anticipating the arrival of cold weather is handled through the calculation of "degree days" using the "K" factor and helps prevent emergency deliveries to empty tanks.

In large firms, this is normally done in the office from information supplied by the driver or customer. In smaller firms, this may be the responsibility of the driver. Careful study and experience with degree days and the K factor causes its calculation to become routine. Different companies may have slight variations, but it is essentially as follows:

1. The standard unit of temperature to predict the customers' needs is the "degree-day." This unit is a measure of the accumulated deficit in the temperature (in degrees F.). Some companies use 70° for spring and fall with 65° for winter.

2. The company calculates, or secures, the mean temperature for any 24-hour day and determines the difference between this and 65° or the figure set. This difference represents the number of degree-days for the 24-hour period. For example, if the mean (average) temperature for the 24-hour period is 50° F. and 65 is the base temperature, the difference is 15

degrees or 15 days. Most companies use a "degree-day clock" which costs very little and gives the number of degree-days from the start of the season, usually September 1.

3. The supplier needs some experience to know the particular customers' ordinary oil consumption rates at the base temperature (65 degrees) and gets this by dividing the total number of degree-days during the previous heating season by the number of gallons of oil used during the same period. This will give the number of degree-days for which one gallon of oil will heat a customer's home and is called the "K" factor. Dwelling houses vary in insulation, glass exposure, etc., and customers vary in habits, with respect to room temperatures.

   For new customers without previous records, the driver-salesman would calculate the "K" factor after the second delivery for the period elapsed between the two deliveries, and repeat again as necessary to get a more accurate "K" factor for the first year.

   An example of working out the "K" factor would be:

   Number of degree-days for the period.........6,000

   Number of gallons of oil used by a customer...3,000

   The "K" factor for this particular home is:

   $$2(6{,}000 \div 3{,}000)$$

   If "K" is less than 1.00, work it out to two decimals. If "K" is between 1.00 and 4.00, work it out to one decimal. If more than 4, re-check the calculation.

4. A reserve is set up for each customer's tank to insure that a customer will always have fuel. This is usually 75 gallons for a 275-gallon tank. The number of gallons on hand after the last filling is always recorded by the driver-salesman on the form provided. (See driver's delivery card sample--this competency.)

5. The next delivery date is calculated by subtracting the reserve from the amount of usable oil at the last filling and multiplying this by the "K" factor which gives the number of degree-days which can elapse before the next delivery. For example, if the supply in a 215-gallon tank at the last filling was 265

gallons and the reserve was 75 gallons, there would be 190 gallons of usable oil. When this 190 is multiplied by a "K" factor of perhaps 2.5, you have 475 degree-days before the next delivery date.

6. The number of degree-days before the next delivery is added to the degree-day log (column 6 of Customer's Control Card, page 61) for the season and gives the next degree-day point at which the delivery should be made. When this date comes up on the degree-day log, the delivery should be scheduled. It is obvious that some customers must be serviced more often than others. It is better to follow the calculated pattern of making sizable dumps for each stop rather than to make every stop and pump only a few gallons.

7. Companies usually maintain two sets of cards for use in delivering heating oils using the degree-day and "K" factor system. The customer's control card is kept in the degree-day file in numerical order according to the number of degree-days shown on the card. The driver's delivery card for the same customer is kept in a separate file and pulled for the driver's use whenever the control card comes up for delivery. The amount to be delivered is figured from the control card and entered on the driver's card before it is given to the driver. The driver must fill in the information concerning the exact date of delivery, the number of gallons delivered, and the quantities in the tank before and after filling. When this card is returned to the office, the new information is transferred to the control card and the entire process repeated to calculate the next delivery date.

8. When using the degree-day system, there are no regular routes or uniform intervals of time due to the unpredictable weather. The degree-days automatically compensate for the differences in temperature and are recorded on the customer's control card as the D.D. Log (column 5--page 61) beginning from September 1 through the following spring.

   Customer control cards are used for purposes other than computing the next delivery date. They usually contain data on customer credit, size of tank, type of heating oil used, "K" factor, amount of reserve, whether summer fill is made or not, and special instructions in addition to the usual name, address and telephone number.

Column headings on customer control cards are usually as follows:

1	2	3	4	5	6	7
Date 19	Credit Date	Gallons Delivered	Gallons in Tank	D.D.* Log to date	D.D.*'s of usable oil	D.D.* Log next delivery

* D.D. = Degree-Days

The driver's delivery card shows the location of the tank, the size of fill and vent pipes, type of connection, rate of flow, credit date, as well as information on each of the deliveries made. The column headings are usually as follows:

1	2	3	4	5	6	7	8
Date 19	Credit Instructions	D.D. Log for Del'y	Quantity Ordered	Gallons Delivered	Quantity		Driver-Salesman
					before	after	

A degree-day chart will save time and computation in determining the degree-days before the next delivery or to calculate a new "K" factor. However, no one will understand the system unless they can do the individual problems.

Storage tanks for heating oil must meet the NFPA Standards and the State Fire Marshal's Rules and Regulations. Much of the teaching material for gasoline storage is pertinent for heating oil storage and will not be duplicated. However, two major aspects of heating oil which differ from tractor fuels follow:

1. The flash point rating of No. 1 fuel oil is Class II, and for No. 2 fuel oil is Class III; both of which are higher than for gasoline. Because of this, oil tanks may be placed adjacent to buildings or even inside them if the size is not more than 275 gallons, and they are properly installed. Heating oil tanks in the 275 gallon size usually used for above-ground storage have a characteristic flat-sided shape and screw-in legs. This makes it possible to pass through ordinary doors for installation inside a building.

2. It is customary for the consumers to buy the tanks rather than use them on a loan or lease basis. The distributor may install heating oil tanks and bill the customer for the cost of the tank and labor, or

> the customer can do this on his own. Before the initial filling, the installation must meet necessary safety standards. If an inspection has not been made by a municipal or state inspector the deliveryman should check the installation. The tanks used for heating oil must not be used by gasoline and vice versa because of safety.

Heating oil deliveries are practically always made with metered pumps which provide accurate records and are especially valuable for deliveries when no one is at home. The meter slip left at the tank or door shows that the delivery has been made and the amount.

The driver-salesman has a major responsibility in refilling to see that the tank does not overflow, either because of miscalculation or too rapid filling. He must also be very careful not to damage driveways, yards, fences, shrubs, etc., either while trying to get close to the storage tank or when moving the hose. If tanks are not equipped with a device to indicate a full tank, the driver must remain close to the cut-off valve at the filler end of the hose. All new tank trucks have pumps which can be set to deliver a given amount and shut off automatically when this is reached, but this is of no help if the tank overflows before the set amount is reached.

Heating oils are low in volatility and have practically no loss from storage tanks situated in the open when the fuel is kept over the summer period. It is to the company's advantage to fill the tanks during the summertime whenever convenient. Most companies offer customer inducements for filling the tanks in the summer. These may take the form of a slightly reduced price, guarantee against a rise in price, or in deferred payments until after September 15. This is usually referred to as the "summer fill program."

Delivering heating oil involves slightly more paperwork for drivers than delivering tractor fuel. In addition to the customer delivery cards, there are usually trip or shift summaries which include record of gallons loaded, sold, and left on the truck; meter readings, miles traveled laden and unladen, remittance analysis, consumption record, mechanical condition of vehicle and driver time analysis. Each company will have its own forms and requirements for doing paperwork. A simple method would be as follows:

1. Use the loading ticket as a trip summary on which the driver records the terminal rack meter readings, the truck meter readings, the gallonage analysis, time record, speedometer miles, and laden and unladen miles.

2. Use the invoice summary to record the remittance analysis showing cash, credit card sales, discounts, credit memos and checks.

3. Make both the loading ticket and the invoice summary the same size so that they may be stapled together and conveniently filed.

LP-gas can be considered as a heating oil and is liquid under pressure; however, the subject matter content for this competency is largely for the conventional types of heating oils. The distribution of LP-gas is usually done by different companies or with different equipment than for ordinary gasoline and oil, and storage of LP-gas for heating was considered with storage for LP tractor fuel.

The subject matter content of this competency can be adapted by the teacher to LP-gas for areas where it is used for most household heat.

Suggested Teaching-Learning Activities

1. The teaching of this competency logically follows those pertaining to tractor fuel selection and storage. It is intended to help train driver-salesmen who will be expected to handle all types of products. However, in case a teacher elects to teach the heating oil competency before the one on tractor fuel, he should incorporate much of the material from fuel selection and from fuel storage in the teaching. In this competency, the writer has grouped selection, delivery, and storage problems together and concentrated on these aspects pecular to heating oil. It is suggested that the teacher bring out in the class discussion the major points of difference between heating oil and tractor fuel operations. These may well be listed on the board as they are developed and recorded in student's notebooks. Such a list would include:

   a. Heating oil deliveries concentrated in winter months

   b. Compartmented trucks needed to carry both heating oil and tractor fuel at the same time. (Stress safety factor of non-mixing.)

   c. Difference in flash points and effect on location of storage tanks

   d. Necessity for a longer hose to service heating oil tanks

e. Difference in method of planning deliveries (regular intervals or extended delivery for tractor fuels, and on the basis of weather--for heating oil)

f. Tractor fuels burn rapidly to produce heat and power while heating oils burn relatively slow and produce heat

g. Others

2. It may be desirable to consider the factors involved in the selection of oil burning furnaces or other home heating appliances, particularly in "pot types" vs. "gun type" burners.

3. The concept of "degree-days" and "K" factors should be thoroughly developed, as it is basic to satisfactory and economical distribution of heating oil. The teacher should secure a supply of forms from a local distributor for practice, or he may mimeograph the samples shown for this competency. If the teacher has difficulty in explaining the degree-day "K" factor system or with the forms, a petroleum manager or a distributor could be used as a resource person.

4. The students should be familiar with the forms used, regardless of whether tractor fuel or heating oil is delivered. It would be well to secure a supply of report forms used by drivers from one or two distributors and have the students practice filling them out. The teacher can make up hypothetical figures to use or borrow an actual report from one of the local distributors.

5. A field trip to see an installation for household heating fuel will be valuable for teaching: (1) the location of the tank, (2) the method of pumping, (3) type of burner used, (4) pipe fittings used, (5) venting, and (6) safety.

6. The suggested time allotment for this competency is as follows:

Class instruction------------	5	hours
Laboratory instruction-------- (including field trips)	3	hours
Total---	8	hours

Suggested Instructional Materials and References

References

1. Bulletin No. 1616. Petroleum Delivery Truck Operation and Maintenance, American Petroleum Institute.

2. Bulletin No. 1614. Drivers' Paper Work, American Petroleum Institute.

3. "Rules and Regulations for the Storage and Transportation of Liquid Petroleum," published by the State Fire Marshal's office for respective states.

4. Publications from major oil companies handling heating oils.

5. Copies of forms used by local distributors such as: (1) customer control cards, (2) driver delivery cards, (3) sales tickets, (4) driver trip reports or daily sales summaries, (5) petroleum prospect cards, (6) grease order blanks, (7) tax exemption certificate forms, and (8) liquid fuel shrinkage reports.

6. A copy of the storage equipment sales and security agreement covering purchase and installation costs for heating oil tanks purchased on a time payment plan.

Suggested Occupational Experiences

1. Riding with a driver-salesman when making deliveries of heating oil and doing routine paper work.

2. Work in the office on either a paying or an observing basis to get practice in figuring "degree-days" and "K" factors.

3. Work around a terminal plant which handles heating oils and tractor fuels.

4. Work in a filling station would probably be of little value.

VI. To be familiar with other products usually available to farmers through petroleum salesmen

Teacher Preparation

Subject Matter Content

Distributors and many farm supply stores carry a rather complete line of items for tractors. These are sometimes referred to as "accessories" and include tires, batteries, oil filters, vee belts, spark plugs, grease dispensers, and anti-freeze. The salesman naturally receives a commission from sales of such items, and it is to his advantage to let his customers know what he can provide. Aside from anti-freeze, which is carried on the truck during the season, most items would have to be ordered and delivery made the following trip.

The function and use of most accessory items in considered in the course in Agricultural Machinery Service Occupations. In this module, only the information the salesman should know in dealing with customers is included.

Anti-freeze

Following tractor fuel, heating oil, oils, and greases, anti-freeze probably makes up the greatest volume of sales. It is seasonal with most sales occurring in the fall, and to some extent throughout the winter months. With several tractors and other engine-driven equipment, and automobiles on a farm, the decrease in price resulting from quantity purchasing makes it worthwhile for the farmer to order enough at one time to carry him through the winter.

The farmer has three choices in anti-freeze. The cheapest is ordinarily wood alcohol sold without a rust preventative. When used in the proper concentration, it will protect the engine from freezing. This methyl alcohol will evaporate, however, and constant testing and adding of alcohol will be needed throughout the winter. Most tractor manufacturers recommend 180° F. thermostats to insure high enough operating temperatures to result in minimum wear on engine parts. This precludes the use of alcohol, as alcohol will boil away if a thermostat of higher than 160° F. is used. Alcohol-type anti-freeze should not be used in diesel engines.

Another choice, which is slightly more expensive, is the methanol-based anti-freezes. These are more highly refined methyl alcohols containing an anti-corrosion agent and possibly other additives such as dye to make it more attractive. The boiling point, while slightly higher than for ordinary alcohol, is still below that of water, so again there is the need for checking and adding as necessary.

The so-called "permanent" types of anti-freeze cost more per gallon but should last all winter without addition unless leaks develop, and may be cheaper in the long run.

Although they last throughout a season, they are really not permanent in the sense that they should be left in the radiators over summer. This is not because the anti-freezing properties are lost, but because the corrosion and rust inhibitors are broken down and thus do not provide this type of protection. It is not even a good practice to attempt to use them a second year as it is difficult to know whether or not the stabilizer which has been added is still effective.

All permanent anti-freezes are glycol-based solutions, usually ethylene glycol. These contain at least three additives: (1) a stabilizer to prevent changes in the glycol, (2) an anti-corrosion additive, and (3) an anti-foam agent. A new type of glycol base anti-freeze on the market is more nearly a "permanent" one than the older types in that it can be left in the radiator until it changes color. This type contains an indicator which changes to a yellow color to indicate when the glycol has lost its stability. When this happens, the radiator should be flushed out and new material used.

The big weakness of glycol-based anti-freezes are that they tend to leak through weak places. When the glycol leaks into the crankcase through a head gasket, it remains and will damage the bearings. In contrast, the alcohol anti-freezes volatilize in the crankcase and pass out through "blow-by" or through the crankcase breather system. For this reason, the farmer must check to be sure everything is tight before using glycol-based anti-freeze. If he suspects it is getting into the crankcase he should immediately change the oil.

Tires

Tractor tires have undergone some changes in recent years to improve traction, floatation, and to reduce road wear. All tractor tires are now broad-based in design, although they fit on the same rims or wheels. If a farmer needs a replacement for his old 10" x 38", he now gets a 11.2" x 38". There is no trouble in mounting, and the floatation and traction are improved. Tire manufacturers provide tables correlating the old and new sizes. Practically all modern tires are now open-centered for better cleaning and traction. They are usually built with curved treads or lugs to decrease their wear when used on the highway. The angle of the lugs is now about 32° which increases the traction over the older 45° of straight-across lugs.

Batteries

Batteries are competitively priced according to the guaranteed length of service. They are rated according to the number of ampere hours of service that may be expected. This depends largely on the amount of lead used, and this is affected by the number, length, and thickness of plates. Replacement batteries must be of the correct voltage.

Oil filters

Oil filters contain either "paper" type elements or "sock" type elements made from cotton waste. The filtering elements may be replaceable or non-replaceable. If the filtering element is non-replaceable, this indicates a "throw-away" filter and requires a completely new filter.

The manufacturer's recommendations for replacement should be followed. Conversion numbers should be checked to make sure that the right one is used in case the salesman does not handle the same make as the original equipment.

Grease dispensers for farm use are either hand pressure-gun type or the pail pressure-hose type. The former may be suited for hand filling or may be capable of also using grease cartridges. The salesman should know what his company carries in stock and know what can be supplied.

Spark plugs

There are many variations of spark plugs, and the manufacturer's recommendations should be followed. Unless the salesman can be certain he can provide an exact duplicate, he should be careful about suggesting that his customer change brands. Manufacturers make a range of plugs in the various sizes to cover the difference in operating conditions. This range is from "cold" to "hot" and the driver-salesman should be able to select the proper number when a customer wants "the next hottest plug or the next coldest plug" for his operating conditions. This competency is covered under the course in Agricultural Machinery Service Occupations.

Vee-belts

Sizes for Vee-belts are determined by the width across the back in inches and the outside diameter in inches, such as $\frac{1}{2}$" x 24". If the old belt is not available, the number in the operator's manual can be equated with the conversion numbers, to provide the right size of another brand. This information is usually printed on the labels of replacement belts or found in handbooks provided by the company.

Suggested Teaching-Learning Activities

1. Understanding of the subject matter content of this competency can be developed through class discussions focused on the question, "What should a salesman know about the accessories available through his company?"

2. Cut vertically through a used, non-replaceable filter so the class can see that regular changing is necessary. This makes a convincing demonstration.

3. Place bright, clean nails and small pieces of brass in two pint glass jars. Fill one jar with new ethylene-glycol-based anti-freeze containing rust and corrosion inhibitors. Fill the other with old anti-freeze of the same type. Place both jars in a warm place or beat them periodically. After several days, noticeable corrosion of the brass and rusting of the nails in the one jar will be evident.

4. Have students practice determining belt sizes needed in a tractor or other piece of equipment when no operator's manual or old belt is available.

5. The suggested time allotment for this competency is:

   Class instruction--------------- 4 hours

   Laboratory instruction---------- 0 hours

   Total--- 4 hours

Suggested Instructional Materials and References

Information and sales brochures usually obtainable from local distributors.

Suggested Occupational Experiences

1. Work as a clerk in a farm supply center or other establishment stocking the accessory items.

2. Work in a filling station where accessories are handled.

VII. To understand the contractual relationship of the company to the driver-salesman and the driver-salesman to the customer

Teacher Preparation

Subject Matter Content

In most instances there is a written contract between the company and the driver. Some contracts specify working hours, salary, or wages for regular time and overtime; retirement and hospitalization; workmen's compensation; unemployment insurance; responsibility in case of accident and other items. Companies usually bond the driver-salesman if collections are made in cash. A contract, whether written or oral, is done to insure a positive understanding between the two interested parties. If a man's work is unsatisfactory or the work falls off, the usual procedure is to terminate employment at the end of the contract period.

Of greater importance than the contract terms is an understanding of the job. The company profit is largely determined by the amount of products it sells over a year's time. It can provide work and pay driver-salesmen only to the degree that it makes a profit. The overall goal is to deliver products with the least possible expense. Management can do much of the planning for the operation and the analysis of day-to-day and month-to-month business, but in the final analysis much depends on the driver-salesman. His ability to increase the number of customers and improve the efficiency of service to those already "on the books" is most important. When the salesman and management work as a team, the gallonage and sales volume increases and everyone benefits.

To accomplish a good team effort, the salesman should be provided with three things: (1) an incentive for more volume, (2) an efficient delivery method, and (3) a plan for sales.

To provide an incentive for more sales, most companies determine a route man's monthly salary based on a predetermined number of gallons delivered, and pay an incentive for all gallons over the base. Base figures and incentive payments may be made on averages for the company if it is large enough, or on industry figures for a state by small companies.

The monthly salary is based on gallonage with an additional straight commission paid for sales of oil, grease, anti-freeze, and accessories. The commissions due the driver-saleman are paid monthly in addition to a regular salary. The incentive payments on gallonage are usually computed each month with payment deferred until the end of the year. At that time, if the labor cost of delivery per gallon exceeded the average labor cost per gallon delivered, management should sit down with the driver to determine the reason. If the same situation continued over the years, it would be difficult to retain an individual driver. On the other hand, if the gallonage times the factor exceeded the annual salary by a comfortable margin, there would be every reason to increase the monthly salary. For salesmen just starting who have no past record of gallonage, a base figure would be established, determined by past company experience.

Under the incentive plan, it is absolutely necessary to have a written contract so that there will be no mistake as to the monthly salary, the base on which incentive pay is determined, and the factor used for the allowable labor cost per gallon.

To increase the volume and improve the efficiency of delivery, some system must be set up to reduce excessive mileage per gallon delivered. This situation will arise under systems where the delivery man depends on the farmers to call in for service or where he "tops-off" the tank each time around regardless of the quantity needed.

Almost any system requires understanding on the part of the farmer as well as the driver-salesman. It is a major responsibility of the driver-salesman to convince customers that it is to their best advantage to have tractor fuel delivered on an "extended delivery" basis, and heating oil on a degree-day basis. Companies changing from an old haphazard system to an extended delivery or automatic refilling system will have some difficulty until it is in full operation, but the economy and efficiency of this type of operation will make money for all concerned.

An extended delivery system for tractor fuel works in the following manner:

1. The driver-salesman maintains a card for each customer, showing dates of delivery and quantities of tractor fuel, or other products delivered. This provides a basis for determining the date of the next delivery.

2. At the time of a delivery, a notation is made on the sales ticket and customer's record card for the date of the next delivery. This is based on the customer's usage, the time of year, and weather conditions.

3. At the end of each day, all of the cards are turned in showing the next delivery date. These are filed alphabetically in folders by week of the next delivery.

4. At the end of each week, the petroleum manager or distributor pulls the cards scheduled for delivery the following week and checks them for credit. A sufficient number of "prospect" cards will be added to provide a full week's work.

5. The salesman sorts his week's work into loads for each of the days and the cards are put in order into a binder for handy reference.

6. The process is repeated each week.

7. In case the customer "calls in" for additional gasoline, the office personnel locates the customer's card in the file folder and informs the customer and moves up the scheduled date of delivery. "Call in" loads not already with the truck are pulled from their regular sequence and put in a special folder so that the driver can give immediate attention if needed. They may be integrated into the current week's schedule or into the following week if that is soon enough, and if he has already passed the customer during the current week.

To make an extended delivery system work effectively it must be followed "to the letter" by all parties concerned. The following are important points:

1. The driver-salesman must make the delivery during the week marked on the last sales ticket no matter what the weather has been so that the customer will have confidence in his regularity.

2. Customer cards must be filled out at the time of delivery and returned to the office daily. In this way the office personnel will either have the card or be able to tell the customer that he is scheduled for the current week. Delivery can be rescheduled for the next day if necessary.

3. Tractor fuel cards must be kept separate from heating oils at all times.

4. Deliveries must be made only to those customers scheduled for a particular day.

5. Tanks must be completely filled, except for expansion room at each delivery. Less than full tank deliveries throws the entire system off, and requires that credit arrangements be worked out in advance.

6. Whenever existing storage tanks are too small to permit off-loading enough fuel at one time to last at least a month, arrangements should be made for the installation of a larger or an additional tank. The prospect of using a tank with an electric pump or an underground tank is usually sufficient inducement to the farmer. Such changes are warranted as long as the gallonage and customer credit are favorable.

7. Eight weeks should be the maximum time between deliveries. This will insure that gasoline refined for a particular season will not be carried over. Customer contact on at least a bi-monthly basis helps develop good company customer relations.

8. There must be an understanding about credit and about discounts for cash payments. The usual plan is to set a delivery date to coincide with the normal cash payment date. The most convenient system is for the farmer to pay a fixed amount based on an average predicted consumption. Adjustments are then made at the end of each six-month period. A route-man may help a customer to improve his credit rating by mentioning advantages of a good credit rating. A driver may also find it necessary to tactfully remind a customer if he has not paid when due. It might be necessary to gradually upgrade a customer from smaller gallonage at fairly frequent intervals to high gallonage when warranted by his payment record.

There will probably not be any written contract between the company and the customer covering the extended delivery system and none is needed.

Some smaller distributors avoid using an extended delivery or automatic refilling system by equipping their trucks with two-way radios to supplement regular time interval deliveries. In this way, "call in" orders are relayed to the driver on the route. This is an improvement with a corresponding increase in efficiency, but it does not avoid having many small deliveries. However, it does tend to serve small quantity customers whose needs do not fit the extended delivery system or those who must buy on a cash basis because of poor credit ratings.

There are many responsibilities between the company and the salesman and between the salesman and the customer which are not written, but are important. Examples include:

1. Driver-salesman responsibilities to the company

    a. The driver's responsibility for servicing his own truck

   b. The driver's responsibility for profitably using his slack time around the terminal for (1) paper work, (2) improving product knowledge, and (3) assisting in maintenance of facilities and equipment

   c. Scheduling and using time properly for calling on prospective customers

   d. Developing new prospects and maintaining a current prospect file

   e. Representing the company in a good manner at all times

   f. Being alert to the efficiency of his truck and keeping the truck assigned up to standard

2. Driver-salesman responsibilities to the customer

   a. The driver's responsibility for knowing where the keys to the customers' tanks are kept and replacing them properly after refilling. This is a major reason for keeping the same driver on the same route.

   b. The driver's responsibility for opening and shutting gates when necessary

   c. The driver's responsibility for leaving the metered slip showing amount of delivery made so that the farmer will find it

   d. The driver's responsibility for picking up the cash or check when necessary because a limit has been placed upon credit deliveries, or when the farmer insists on paying at time of delivery. The trust which exists between some driver-salesmen and their customers is evidenced by the fact that they leave cash or signed checks in a place known only to the driver. The cash may or may not be in monthly budget envelopes. Often the amount on the signed check must be written in by the driver.

   e. The driver's responsibility for handling the truck to prevent damage to the customer's property

   f. The driver's responsibility for avoiding safety hazards or taking corrective action when safety rules are violated

g. Informing the customer when it is to his advantage to buy in quantities but not to the extent of becoming overstocked

h. Informing the customer about product information so that the customer can safely and wisely buy with confidence on the recommendation

i. Informing the customer concerning time limit and form to use to secure refund for refundable fuel taxes paid. Some drivers handle all this for customers, who merely sign their names.

Suggested Teaching-Learning Activities

1. Class discussion will bring out the points presented in subject matter content. Individual students will undoubtedly be able to provide examples or offer supplementary information from their own experience. Copies of employment contracts may be used for examination during the discussion.

2. Ask the class to give possible objections to the extended delivery system and list them on the chalkboard. Challenge the class to provide rebuttals to the objections that would be made by a good salesman, and list these in another column.

   The merits and objections of this system should be similar to the following:

Objections by Farmer	Answers of Salesman
1. No money to pay for more than 100 gallons every two weeks.	We will keep your tank full and every two weeks you send us a check for the usual amount. We will settle up at the end of the year and it will mean less bookkeeping and less wear and tear on the driveway.
2. I don't want a full tank as I think someone is stealing it.	Perhaps we can move the tank nearer to the house, but if not let's put some locks on it and only you and I will know where the key is kept.

3.	Gasoline gets stale when it stands.	We put additives in the gas to prevent this and there is no trouble unless you keep it more than three months.
4.	I don't want to run out of fuel, and my work varies from week to week. How can you be sure there will be gas when I need it?	From past records, I know about how much you use each week in busy and slack time, good weather and bad. It would be rare for you to run out, but if you do, just call in and I will deliver immediately.
5.	How does this new system help me?	You will have fewer tax records to keep and less chance of missing any refund dates. There will be fewer deliveries and less chance for cutting up the driveway in bad weather.
6.	I don't like someone filling the tank unless I tell them to. I prefer to phone in my order.	You may continue to phone in if you want to, but almost everyone prefers to be served automatically. This saves them the bother of phoning and the worry about forgetting to phone. Try the new system and if you do not like it, you can change back.

7.	What will I do for oil and grease if I need some and you will not be stopping for three or four weeks?	We have special prices twice a year in the spring and fall, and you can save money by ordering a six-month supply at that time so you will always have a supply on hand.
8.	If I cannot pay for a full tank, I will lose my cash discount.	If you pay once a month on a regular basis, you get the same discount as cash on delivery. I will leave a set of envelopes, one for each month, and you can send it in or I will pick it up on delivery. At the end of the year, we will balance out. If you have paid for more fuel than you received you will get credit, and if it is the other way around we will bill you for it. We can even adjust the payments next year to take care of it. This is known as the "deferred payment" plan.
9.	I'll never know when you are coming.	I will always mark the week of my next delivery on the ticket I leave. If you need something or want me to pick up the payment envelopes, just put a note in the tax record booklet that I will hang in the shed (or wherever you designate).

10.	Other objections as offered by the class.	Other responses as suggested by the class or provided by the teacher.

3. The time allotment suggested for this competency is:

Class instruction---------------- 3 hours

Laboratory instruction----------- 0 hours

Total--- 3 hours

Suggested Instructional Materials and References

References

1. Major companies usually have some printed or mimeographed sales plans indicating (1) how their systems operate for extended delivery of tractor fuels and their use of degree-days for heating oil, and (2) the basis of incentive payments to driver-salesmen. These would be useful for class use.

2. Copies of sample contracts from major oil companies for class use.

3. Publication 1609. The Driver's Handbook, American Petroleum Institute.

Suggested Occupational Experiences

Occupational experience is not needed to develop this competency. However, all of the occupational experience suggested for previous competencies would contribute to some extent to this competency.

VIII. To understand and appreciate the safety laws and regulations pertaining to the delivery and storage of liquid petroleum

Teacher Preparation

Subject Matter Content

Safety cannot be segregated and taught successfully in a separate module any more than it can be legislated or ensured by the publication of a set of rules from the state fire marshal. Safety has been brought up repeatedly in the teaching of the competencies of this module and the best time to teach it is when it comes up in connection with other aspects of the subject matter content. However, certain aspects which may not have been discussed during the previous teaching are presented here. By considering safety as a separate competency at the end of the module, the teacher has an opportunity to again reinforce the earlier teaching of safety.

Many people pay "lip service" to the importance of safety with respect to liquid petroleum when talking with others, and then proceed to take chances themselves. More than a mere appreciation of factors are involved and the teacher should strive for an understanding of the personal and property hazards involved. For a driver-salesman, safety must become a habit. He must be continually alert to what he is doing and yet at the same time perform safety checks without fail, such as checking the ground strap before filling each tank and before mounting the cab each time he moves the truck.

The major hazards in liquid petroleum deliveries are traffic accidents and fire. Prevention is much better than remedial action.

Fire protection may have been considered in other classes. The students should understand the basic principles of extinguishing a fire and how this is accomplished by the several types of fire extinguishers. While the tank truck driver is primarily concerned with gasoline and oil fires, he should also know about the other classes of fire in case adjacent buildings or electrical fires are involved. The following can be used as a review for students or classes who have studied it previously.

Fires are classified as follows:

Class A - Fires in ordinary combustable materials such as wood, paper, weeds, etc.

Class B - Fires in flammable liquids and greases

Class C - Fires in "live" electrical systems or equipment

In order for a fire to occur three elements are needed. These three essential elements are fuel, oxygen, and a source of ignition. The fuel must be in the vapor stage and oxygen is supplied from the air. The source of ignition may be supplied from the air. The source of ignition may be supplied either from an existing flame, from an electrical spark, or from some source of heat. In order to extinguish a flame it is necessary to remove the oxygen or the fuel. Once a fire occurs, it is very difficult to remove the fuel, but cooling to inhibit vaporization may be effective. Usually fires are controlled by smothering the fire, which prevents resupply of oxygen needed to support combustion.

Portable fire extinguishers may be any of the following types:

Type 1 - Dry chemical, which is effective for Class B and Class C fires. This can be used against Class A fires if a quenching agent such as water is also supplied.

Type 2 - Carbon dioxide (CO_2), which is effective for Class B and Class C fires only

Type 3 - Foam, which is effective against Class A and Class B fires

Type 4 - Vaporizing liquid (carbon tetrachloride), which has some effect on Class B fires. This type is rapidly becoming obsolete because of danger from fumes and possible damage to the skin.

Type 5 - Water which is effective in any form for Class A fires and against Class B fires in the form of a fog. It may be used to cool equipment and protect personnel and adjacent buildings, but should never be directed onto a petroleum blaze. It will spread the fire without putting it out.

All tank trucks carry portable extinguishers and the drivers should be responsible for knowing where they are located at all times, and how to use them. The usual types carried are types 1, 2, or 3. Fire extinguishers must be inspected and serviced according to state regulations. This is not usually a driver's responsibility other than to report when they need service.

In case of fire while loading, the procedure is:

1. Stop the flow of gasoline or oil.
2. Call for assistance but remain with your vehicle.
3. Close dome cover if possible.
4. Do not attempt to move vehicle.
5. Fight the fire with portable extinguisher until it is exhausted, and then by any other available means. Fires in open domes may be smothered with a jacket or blanket.

6. Notify your supervisor.

In case of fire while en route, the procedure is:

1. Move the vehicle off the highway and away from buildings and trees if possible.

2. Shut off the engine.

3. Fight the fire with the portable fire extinguisher.

4. Remain with the vehicle but have someone call the fire department.

5. Notify your supervisor before moving the vehicle, even though the fire is out.

In case of fire while making a delivery, the procedure is:

1. If the fire involves the vent or fill pipe, stop the flow of gasoline or heating oil and shut off the truck motor if it has been used for pumping.

2. If the fire involves the vehicle, fight it with the portable extinguisher but do not attempt to move it.

3. If the fire involves buildings or automobiles, close valves, disconnect or reel up hose and move truck out of range. Remain with your vehicle and have someone else call the fire department, and notify your supervisor.

Traffic accidents are always possible, but good drivers may go through an entire working career and never have a serious one. However, in case of accident, the procedure is:

1. Stop at once and turn off the motor.

2. Take all possible precautions to avoid other accidents including the setting of signal flags and night lights.

3. Assist injured persons if necessary, but do not attempt to move an injured person until the doctor arrives except to move him out of danger. Have someone else call a doctor or ambulance and do not leave the vicinity of your vehicle.

4. Obtain names and addresses of person or persons involved and witnesses. Get the license number whenever possible.

5. Have someone phone for a policeman and notify your employer.

6. Be courteous and show your license readily but do not argue or discuss the accident. Do not make any statement until authorized by your employer.

7. Report every accident to your employer as soon as practicable no matter how small or who is at fault.

8. Do not stop for an accident which does not involve your truck unless your help is absolutely needed, and then only after you place it in a safe position.

Drivers are sometimes assigned the responsibility of cleaning a tank when changing from one product to another. There is an increasing trend to have this done by special companies who do nothing but steam out and repair tanks. In case the driver does nothing more than drive his truck to the specialized place of business, he should still observe safety precautions while in the vicinity.

Tank cleaning must be done in the open, away from other vehicles or sources of ignition, and it involves the following:

1. Removing all of the existing contents by opening draw-off faucets, draining all compartments, piping and hoses, and cleaning out any depressions or pockets where the product may have collected.

2. Dry-mopping the inside of each compartment through the dome opening.

3. Inspection by mirror and approved flashlight or extension light to insure that the interior is clean, valve sumps and lines have been drained, strainers removed and check valves open.

4. Filling with water to overflowing or using low pressure steam when necessary. Steam is chiefly used for the removal of heavy products such as asphalt, and care must be exercised to avoid static electricity generated when it enters the tank. This hazard dictates that the truck be kept properly grounded.

5. The tank must be ventilated by an air blower, or by natural wind currents.

When repair work does not need to be performed on the tank, the cleaning process may consist of merely draining out the old product, filling and draining out a tank full of water and then refilling with the new product. When this is done, every effort should be made to go from a higher octane product to a lower octane except in the case of heating oil. With heating oil, there is always the possibility of explosion if a small quantity of gasoline gets to the burner.

Driver-salesmen will ordinarily not do shop repairs. If any mechanical work the driver does takes place in the open with the truck grounded, there is little danger of sparking or static electricity.

Suggested Teaching-Learning Activities

1. The teacher should emphasize that the practice of safety should become a habit.

2. Bring to class newspaper clippings of accidents involving petroleum products. Use these to start class discussion based on the general question, "What should a driver-salesman know and do for his personal safety as well as that of others?" This will involve the three classes of fires, the five types of extinguishers, and principles of fighting fires.

3. The procedures for driver-salesmen to follow in case of fire involving loading, en route, travel, or in delivering may be mimeographed and passed out; or written on the chalkboard and copied by the students. The same applies to the procedure to follow in case of accident. These should be taken up in class discussion to answer questions which the students may have.

4. The steps in tank cleaning would be best handled by class discussion. A trip to see tank-cleaning in progress may be hazardous with a large group.

5. Demonstrations of fire fighting and fire fighting equipment may be arranged with fire officials at nearby sites.

6. The suggested time allotment for this competency is:

Class instruction--------------- 3 hours

Laboratory work field trip------ 1 hours

Total------------ 4 hours

Suggested Instructional Materials and References

Instructional materials

"Tank Truck Fires," 16mm sound color film, American Petroleum Institute, New York.

References

1. Publication 1609, Driver's Handbook, American Petroleum Instutute, New York.
2. Accident Prevention Manual No. 13, Cleaning Mobile Tanks Used for Transportation of Flammable Liquids, American Petroleum Institute.
3. Accident Prevention Manual No. 8, Safe Practices in Bulk Plant Operations, American Petroleum Institute, New York.
4. Publications from state fire marshal's office and local sources pertaining to safety and petroleum fires.

Suggested Occupational Experiences

Safety is something for which competency cannot be developed independent of other work. Any of the previously cited occupational experiences can contribute to the development of this competency.

IX. To be able to meet the requirements for a chauffeur's license and drive a truck carefully and safely (This competency is best suited to the post-high school level.)

Teacher Preparation

Subject Matter Content

Before an indivudial can perform the service of delivering petroleum products to a farmer or function as a salesman after he gets there, he must be able to handle a truck and hold the proper kind of driver's license.

The different kinds of driver's licenses and the requirement for each vary between the states. Generally there are two types--an operator's license which may be secured at age 16 and is valid for driving privately-owned vehicles not "for hire"; and a chauffeur's license which cannot be secured until age 18 and is required for the operation of vehicles where a fee is charged for transporting people or products.

In most states, a chauffeur's license is mandatory for driving tank trucks, other than those self-owned. The rules and regulations for obtaining one should be familiar to the teacher and to many of the students. The biggest additional requirement for passing the examination over that for securing an operator's license is to know the truck-driving regulations. While there may be some variation between states, the regulations pertaining to trucks usually include:

1. Requirements on overtaking another vehicle
2. Requirements for crossing a railway grade crossing
3. Requirements for use of flags or lighting at night on loads extending beyond the bed of the truck
4. Requirements for safety equipment (flags, fusees, fire extinguishers, etc.)
5. Steps which must be taken in the case of a breakdown on the highway
6. Requirements for mechanical turn-signals
7. Prohibition against driving a vehicle if cargo is leaking its contents
8. Requirements for flaps on the rear wheels to prevent throwing dirt and water on following vehicles
9. Requirements for marking of explosive contents
10. Width limitations (usually eight feet), height limitations (usually 13 feet, 6 inches), and length limitations (usually 35 feet)
11. Maximum weight per axle, total loaded weight (maximum gross weight, maximum wheel load per inch of tire width)
12. Although not applying to the trucks a driver-salesman would normally handle in farm deliveries, he must know the limitations on other types of vehicle dimensions in order to pass the chauffeur's test. These include:
    a. Length of a passenger-type bus (usually 40 feet)
    b. Length of a municipal bus (usually 48 feet)
    c. Length of a commercial tractor and semi-trailer (usually 55 feet)

d. Length of any other combination (usually 60 feet)

Farm boys usually learn to drive a truck even before age 16 while engaged in farm operations off the highway and will probably come to this class with an ability to handle the usual two-and-one-half ton truck with a long wheel base and two different ranges of gears. With this background, the transition to driving a petroleum truck safely is not too difficult. This may explain why some farm boys secure chauffeur's licenses soon after graduation from high school, and find employment as tank truck drivers.

Although it is legally possible for a man 18 years of age to drive a tank truck, most companies would not care to entrust an expensive vehicle and its potentially explosive contents without assuring themselves that he can handle it carefully and safely. There is no difference in the rate for insurance coverage because of the age or experience of the tank truck driver, but every company wants to keep its claims low to avoid increase in rates or cancellations. It is the usual practice of companies when hiring new drivers to provide some sort of "breaking-in" training to be sure that the new man can handle the type of equipment they operate. This may be merely a "check out" with an empty vehicle. The usual operations involve: (1) getting the vehicle into position at the loading dock, (2) negotiating the usual starts, stops, back-ups and turns necessary to safe operations, and (3) safe operation on the road, including overtaking, speed limit, and grade crossings.

While some companies may hire drivers with a minimum of "checking out," others have a very complete and thorough procedure to insure that they are (1) honest, (2) have emotional stability, (3) are physically fit, (4) capable of doing the work, and (5) have the proper attitude toward work, safe driving, and meeting the public. The American Petroleum Institute recommends the following:

1. Pre-employment evaluation including: the completion of application forms to provide basic information and previous experience, the checking of possible traffic offenses against his license, the checking with previous employers on honesty, emotional stability, etc., and a complete physical examination by a competent physician.

2. Qualifying-tests to determine traffic knowledge, legible handwriting, and sufficient arithmetic ability to handle paper work.

3. Behind-the-wheel testing, including at least two tests in each of the following situations:

a. Left turn

b. Right turn

c. Traffic lights

d. Stop signs

e. Railway crossing

f. Traffic flow

g. Backing

h. Ascending steep hills

i. Descending steep hills

j. Parking

4. Determining driver attitudes which are considered more important than knowledge of traffic regulations, sound driving practices, and mechanical skill in avoiding accidents. (This must necessarily be a subjective judgment and can well be made by several persons as they talk with or observe an applicant.)

   Poor driver attitudes include the following:

   a. Overconfidence that transcends good judgment and common sense

   b. Willful disregard for the rights and feelings of others (discourtesy and poor driving manners)

   c. Impatience with resulting loss of good judgment.

   d. Worry over domestic or financial matters that impairs ability to concentrate on the job

   e. "Daydreaming" and failure to keep the mind on the job

   f. Disregard for company rules which may prohibit unauthorized passengers, reporting or working under the influence of liquors or narcotics, falsifying records or time sheets, smoking or carrying matches (other than safety matches) near a delivery unit, leaving the vehicle while unloading, or using company equipment for other than company business

The training of drivers once they have been hired varies from the bare minimum to a complete program including:

1. Orientation to familiarize the new driver with the equipment and the people in the areas where he will work, emphasizing the purpose of his work

2. Product knowledge, particularly the meaning of flash points*, what products flash below normal atmospheric temperatures, the importance of not mixing liquids with low and high flash points, specific information concerning the company's brands and names of products

3. Appearance, courtesy, and public relations which have a strong influence on the company's reputation with clients

4. Driving to correct deficiencies observed during the initial driving tests and to emphasize "defensive driving". (The defensive driver is constantly alert and makes allowances for the mistakes of others so as to be able to take preventive action in dangerous situations.)

5. Safety equipment which is carried on tank trucks with instruction on how to use it in emergencies. This will be covered in detail under competency number VIII of this module.

6. Loading procedures should include:

    a. Determination of the proper loading location for each product

    b. Keeping clear of a spill-area until clearance is received

    c. Positioning the truck with engine and electrical equipment shut off, parking brake on, and truck in gear

    d. Identification of color codes on pipes or other methods for making sure the right product is being loaded

    e. Connecting the ground cable before opening the dome cover to reduce hazard of static electricity

    f. Making sure that loading instructions are clear, and correct products are loaded in the right quantities

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* The flash point of a liquid is the minimum temperature at which it gives off flammable vapors in sufficient quantity to burn.

g. Making sure that all compartments, lines, meters, etc., are empty in order to avoid mixing

h. Making sure that the stop meter is set at the proper quantity for each compartment

i. Keeping the truck's cab unoccupied during loading operations

j. Remaining near the truck during loading operations to insure prompt action in emergencies

k. Keeping all dome covers and all valves closed except the ones being used during loading

l. Carefully inserting the downspout in a vertical position into the compartment to minimize release of vapor and being careful to avoid static electricity

m. Never tying or blocking the loading valves and being careful to prevent overflows when manual valves are used

n. Never exceeding the loading mark on a compartment and drawing off any excess through the proper unloading valve before leaving plant. Dispose of as prescribed by the company directive.

o. Never inserting tools or taking samples during filling operations because of danger from static electricity

p. Looking to be sure that the loading arm is retracted properly, and all dome covers are closed and securely fastened

q. Disconnecting the bonding or ground cable before moving the truck

r. Using clay, sand, or earth to absorb any spill, and removing this to a safe location but not into a sewer or on surrounding property

s. Never attempting mechanical or electrical adjustments while truck is at the loading rack

t. Loading dry cargo so it will not shift in transit

u. Being careful in loading batteries to not damage terminals or cause leakage. Be sure to wash down with water and baking soda in case of spilled acid.

v. Protecting against weather when necessary by use of a tarpaulin

7. Delivery procedures to include:

   a. Positioning the truck near the tank without damage to driveways, lawns, buildings, etc.

   b. Making sure that the tank contains the same kind of product that is being delivered to avoid mixing

   c. Making sure that the tank has sufficient capacity to the amount ordered

   d. Checking against fire hazards and not unloading until corrected, e.g., smoking, open flames, etc.

   e. Making sure that the proper delivery hose connection is made before opening the valves or starting the delivery pump

   f. Checking for leaks and stopping immediately until repairs are made

   g. Remaining near the truck, watching the filler opening, and being able to shut off the flow quickly in an emergency

   h. Keeping dome covers closed

   i. Being alert to improper venting and reporting improper installation to superior

   j. Completely draining the hose before removing to avoid spillage

   k. Should a spill occur, stopping flow of product, obtaining fire extinguishers, warning people away, notifying police and fire departments, keeping vehicle shut off, remaining close to the scene until the area is made safe

   l. Disconnecting hose from tank when delivery is completed and replacing fill cap and cover

   m. Closing and checking all valves and dome covers before departing

   n. Reporting any delay, hazardous condition, or dissatisfaction of customer to superior

o. Never delivering directly onto a farm tractor or other equipment on which the motor is running

8. Fire protection (See competency VIII of this module.)

9. Invoicing and accounting procedures in accordance with company directives including time cards or logs, loading tickets, tax rebate forms where applicable, invoices, delivery receipts, fire and accident reports in vehicle, maintenance reports, and trip summaries when required (Companies differ in procedure, but all should have some way of checking on the complete history of each trip to include, gallons loaded, gallons sold, gallons left on truck, meter readings, driver time, miles traveled laden and unladen, remittance analysis showing cash, credit card sales, checks, etc.)

Company policy may dictate the driver's responsibility for the proper maintenance of the vehicle to which he is assigned. Unless there is fleet maintenance, the driver will be expected to do the usual serving, including: washing, lubrication, checking the tires, and reporting any needed repairs which are beyond the usual tightening of bolts, etc. Tank cleaning to remove dirt at periodic intervals or when changing from one type of fuel to another such as gasoline to fuel oil is usually a responsibility of the driver.

Before starting to load or drive a truck, the driver has a responsibility for vehicle inspection even if the maintenance work has been done by others. This includes checking on the following:

1. That the fuel tanks to supply the truck motor are full
2. That the oil level in the crankcase is adequate
3. That the radiator has enough water in the summer and has adequate anti-freeze in the winter
4. That tire pressures are correct and the wheel lugs tight
5. That the wheel chocks, fire extinguishers, emergency flags, electric lanterns, etc., are in order
6. That the water is drained from the air tanks for all trucks equipped with air brakes
7. That hoses and tools are all in place and serviceable

8. That any evidence of previous damage to the vehicle or equipment has been reported

9. That the license plates and signs are clean

10. That the brakes are working properly, including the low pressure alarm for air brakes

11. That all lights including stop and turn signals, horn, and windshield wipers operate properly

12. That the steering-mechanism and dash instruments operate properly

13. That the windshield, cab windows and mirrors are clean and that the side-mounted rear-view mirrors

14. That any leaks in tanks, valves, and piping have been reported

15. That tire chains are carried if required. (The industry prefers not to use them, and in some states they may be prohibited, just as the grounding chain is no longer used. It has been replaced with a rubber-covered metal strap.) The weight of the truck and the design of the tire tread is considered sufficient for traction under most driving conditions.

Filling operations at the bulk plant are generally under the supervision of a terminal or petroleum manager. However, the tank truck driver is usually involved to insure that he gets the right amount of the proper material and that his personal safety and that of his truck are not jeopardized. In small organizations, the driver often assumes full responsibility for the entire loading operation. Cooperation and understanding between personnel around a bulk plant is vital to smooth and safe operations.

Prior to leaving the plant, the driver should plan his route to avoid congested areas. He should then make all of the delivery stops, and return to the terminal with the least number of gallons remaining in the tanks and the fewest number of miles driven with an empty vehicle. In addition to all of the other points of good driving which should be observed, the tank truck driver should be careful never to pass fires on or near the road without first assuring himself that this can be done without hazard of igniting vapors.

In the event of a breakdown on the road, the driver should (1) get off the road as far as possible, (2) set out flags, markers, or lights in accordance with state regulations. This is usually 100 feet in front, 100 feet in rear, and usually at least 10 feet on the traffic side of the truck. To park the truck, cut the front wheels toward the curb, set the hand brake and block the wheels. The driver can then try to determine the cause of trouble and send word to his supervisor.

The operation of the metered pump (or pumps) which are mounted on the truck and the proper use of the hose reeling devices are the responsibility of the driver and must be learned before he works on his own. Although all of his equipment follows about the same pattern, there is enough variation between different makes to require some orientation and supervision before the driver starts making deliveries. In all probability, an experienced operator will ride with a new driver long enough to insure that he can properly operate all features of the truck and observe all safety precautions.

Since distribution to farmers usually does not involve crossing state lines and PUCO licensing would not be involved, it is omitted in this competency.

Suggested Teaching-Learning Activities

1. The points taken up in the subject matter content should form the basis of a class discussion led by the teacher rather than be given as a lecture.

2. The student must be encouraged to take the requisite action to secure a chauffeur's license on his own, in preparation for the time when he must qualify as a chauffeur in order to be employed. This includes:

    a. Learning to operate a large truck if he does not already know how. Local trucking firms will sometimes loan a truck for this purpose.

    b. Preparing for the chauffeur's examination.

    c. Observing the operation of truck operators whenever possible. Testing is really accomplished at the time of taking the chauffeur's examination. Informal testing by the teacher or other qualified person for grading purposes may be in order.

3. A field trip to see the operation of a bulk plant, including the filling and operation of a tank truck may be helpful. It may have to be done in small groups because of safety.

4. If a field trip is not possible, a competent driver-salesman might be invited to the class as a resource

person to answer questions arising from the class discussion. However, as in the case of field trips, this may be done in connection with the other competencies.

5. Students may have been enrolled in driver education classes and know the fundamental principles of motor car operation on the road. While truck driving is similar, there are certain additional items and some modifications which are peculiar to truck driving. The teacher should consider these in a class discussion following the question, "What are the steps in truck operation on the road covering all situations from the time the driver boards the loaded truck in daylight until he returns after dark?" List on the board the students' responses and adjust the sequence. An alternative way would be to assign this topic for individual or committee written work with possible collation on the board after they have finished. Note that this sequence would generally follow that beginning with number 4 on page 16 of the Driver's Handbook (API publication 1609) referred to at the end of this module.

6. Laboratory instruction could well be centered around the practice of filling out forms used in the industry. These forms are:

   a. Usually required prior to employment

   b. Usually encountered during the course of delivery. The forms could be taken from the appendixes of API Bulletin 1608: Driver Selection and Training Guide, and includes

      1) Typical employment application forms

      2) Typical physical examination forms (in cooperation with school nurse)

      3) Typical traffic and driving knowledge questionnaires

      4) Typical questions on characteristics of petroleum products and emergency controls (This may have been covered under competency No. VIII, Safety.)

      5) Typical driver-performance check by qualified driver

7. Unless there is an unusual opportunity for placement, time for considering this competency should be limited. The suggested time allotment for this competency is:

Class instruction----------------	3	hours
Laboratory instruction----------	1	hours
Total--	4	hours

Suggested Instructional Materials and References

Instructional materials

1. Practically all major oil companies have career information material available, with some of it bearing directly on this competency. (This can be secured and made available for browsing by the student on his own time if he is interested.)

2. Publications of the American Petroleum Institute

   a. Publication 1526, A Future for You in Petroleum Marketing 1965.

   b. Publication 1545, Opportunity Around the Corner.

   c. Bulletin 1608, Driver Selection and Training Guide 1960.

   d. Bulletin 1609, Driver's Handbook 1960.

   e. Bulletin 1616, Petroleum Delivery and Truck Operation and Maintenance.

   f. Student booklet, Careers in the Oil Industry.

3. Marketing filmstrip Number 1, available from the American Petroleum Institute, is of interest to teachers but of doubtful value for use with classes. It was prepared largely for distributive education teachers for use at company and association sales meetings to show how the part-work, part-study program operates in training young men for careers in petroleum marketing. This may be avaliable on loan from a distributive education teacher or supervisor. They are intended to be purchased by the companies at a cost of $5.00 and given to distributive education teachers after the initial showing.

The filmstrip includes 20 frames in color and requires 23-25 minutes for presentation. There are two scripts which come with the filmstrip, one for oil marketing personnel use and the other for general audiences. (Note to teachers: after previewing, it should be easy to select the frames most applicable for either the introduction of this module or in connection with the teaching of this competency.)

Suggested Occupational Experiences

1. Bonafide occupational experience will be difficult to secure for this competency because of the licensing requirements and the absence of need for a helper. Not only do companies consider that only one man is necessary both to drive and operate a tank truck, but many have the policy of prohibiting an extra person in the cab even though he is on the payroll. This is due to insurance and liability laws in case of accident. It may be desirable for the teacher to arrange with the company for permission to have students ride with drivers to become familiar with the operation of the truck, even though they do not receive remuneration. It may also be possible for the students to observe loading operations, and then drive in personal cars to follow the truck and observe delivery procedures.

2. Although not contributing to the development of driving competency, any kind of work around a bulk plant or installing tanks on the farm will contribute to this competency. This may be performed on a part-time or summer job basis before graduation.

3. Any kind of driving of large trucks with heavy loads, such as milk collection trucks, will assist in this competency even though it will not provide occupational experience in the operation of the pumps and safety precautions and regulations.

Suggestions for Evaluating Educational Outcomes of the Module

It will be extremely difficult to evaluate the educational outcome of this module on the desirable criterion of whether or not the student is putting into practice what he has learned from his school experience. It may be five or more years before the effectiveness of this module can be objectively evaluated.

Although only a few of the members of a class may eventually earn their living as successful salesmen, it is believed that the development of the majority of the competencies will be useful to all the students because of the minor or indirect relationships to many off-farm occupations. Probably every member of the class will eventually own and operate an automobile and many will use trucks. This module was written from the point of view of farm tractor operation, but there is application for anyone who comes in contact with the products of the petroleum industry. Because of these circumstances, evaluation at the time of completing this module or upon graduation after completing the course in Agricultural Supply--Sales and Service Occupations may have to be more subjective than desired. However, it should include appraisals by the students and by someone who may be in a position to observe the effect of the training upon the student, as well as the student. Such appraisals might be made by using the check list indicated below:

Check List for Evaluating the Educational Outcomes of the Module on Petroleum and Petroleum Products--Sales and Service

Question Pertaining to Competency	Yes	No	To Some Degree	Not Observed
1. Can the student apply the following in selection of tractor fuels? Octane and cetane numbers Compression ratios Additives Promoters Deposit modifiers Metal deactivators Detergents Dyes				
2. Can the student compare LP-gas to gasoline and heating oil with respect to storage, application to tractors, application to heating, water, crop drying, household brooding, etc.?				
3. Can the student compare additives used in lubricating oil with those in tractor fuel?				
4. Can the student apply the following in the selection of gear oils and greases? SAE numbers Metallic soaps Shear stability Dropping point Multi-purpose grease				

	Question Pertaining to Competency	Yes	No	To Some Degree	Not Observed
5.	Can the student explain the delivery of heating oils on the "degree-day" basis including the calculation of "K" factor?				
6.	Can the student explain the "extended delivery" or automatic refill system for tractor fuels showing the advantages to the farmers as well as to the companies?				
7.	Can the student explain how the annual salary of a driver-salesman is determined under an incentive plan?				
8.	Can the student explain what items are covered in written contracts and what items are the responsibility of the driver to the company, and his responsibilities to the customer?				
9.	Can the student recall and explain the critical points he should know as a salesman in talking to the farmers about tires, batteries, anti-freeze, oil filters, and other necessary items?				
10.	Can the student recall, without reference to notes, the salesman's procedure in case of fire or accident?				

The teacher is not expected to include either the student's own evaluation of his abilities listed on the check list, or the evaluation of others. It is believed that the student will have a much better appreciation for the grade he receives if he has an opportunity for self-appraisal. There is no objection to using this check list at the end of the teaching of each competency for grading or as a basis of transition from one competency to another.

It is not intended that this check list be all-inclusive, and both teachers and students are encouraged to add pertinent questions.

Reactions of parents and school officials will be helpful in evaluating the educational outcomes of this module, since there will be only a few instances where the appraisals of employers can be secured.

Because of the limited opportunities for employment in the area of this module while in high school, it will be difficult to have this aspect reflected in the course grade. Some credit should be given to the individuals who develop opportunities for observation and some participation even though on a non-paying basis. This may well be reflected by the "attitude" of the individual toward the subject matter content and the occupational experience.

A basis of grading for this module might be:

Attitude toward the subject matter and occupational experience	30%
Participation in class discussion, laboratory work, etc.	30%
Grades on written quizzes at the close of each competency	15%
Grades on the students' notebooks and special reports (one could well be assigned to each student during this module)	15%
Grade on the final examination	10%
Total	100%

Sources of Suggested Instructional Materials and References

Instructional materials

1. "Marketing Filmstrip Number 1," available from the American Petroleum Institute, is of interest to teachers, but of doubtful value for using with classes, unless it is carefully edited to insure the right effect. It was prepared for distributive education teachers to use to show how the part-work, part-study program operates to train young men for careers in petroleum marketing. This may be available on loan from a distributive education teacher or supervisor. These were intended to be purchased at a cost of $5.00 by a company or association, and given to distributive education teachers after the first showing. The filmstrip includes 20 frames in color and requires 23-25 minutes for presentation. There are two scripts which come with the filmstrip, one for oil marketing personnel use and one for general audiences. 1271 Avenue of the Americas, New York 20, New York.

2. "Tank Truck Fires," 16mm sound color film, 15 minutes, American Petroleum Institute, 1271 Avenue of the Americas, New York, New York. Available for purchase ($90.00) and possibly for loan from a major oil company which produced it.

3. "Selecting and Storing Tractor Fuels and Lubricants," color filmstrip, Southern Association of Agricultural Engineering and Vocational Agriculture, Athens, Georgia.

4. Films or filmstrips available from major oil companies.

5. A copy of a local distributor's storage equipment sales and security agreement covering purchase and installation costs for heating oil tank purchases on a time-payment plan.

6. Copies of forms used by local distributors for:

   a. Customer control cards

   b. Driver delivery cards

   c. Sales tickets

   d. Driver trip reports or daily sales summaries

   e. Petroleum prospect cards

   f. Grease order blanks

   g. Tax exemption certificate forms

   h. Liquid fuel shrinkage reports, etc.

7. Major companies usually have some printed or mimeographed sales plans indicating (1) how their systems for extended delivery of tractor fuels and use of degree-days for heating oil operate, and (2) the basis of incentive payments to driver-salesmen including examples of how annual salaries are determined.

8. Publications and illustrative materials on heating oil are usually obtainable through local distributors of major oil companies.

References

1. The following publications can be ordered from the American Petroleum Institute, 1271 Avenue of the Americas, New York 20, New York.

   a. Accident Prevention Manual Number 13, Cleaning Mobile Tanks Used for Transportation of Flammable Liquids.

   b. Accident Prevention Manual Number 8, Safe Practices in Bulk Plant Operations.

   c. Bulletin 1609, Drivers Handbook, 1960.

   d. Bulletin 1608, Driver Selection and Training Guide, 1960.

   e. Bulletin 1614, Drivers Paper Work.

    f. Bulletin 1616, *Petroleum Delivery Truck Operation and Maintenance*.

    g. Publication 1535, *Buy on Performance*, 1959, no charge for single copies.

    h. Publication 1509A, *Classification of Internal Combustion Engine Service* (to guide the choice of crankcase oils), 1960. Price: 25¢.

    i. Publication 1609, *Drivers Handbook, 1960*. Price: 30¢.

    j. Publication 1526, *A Future for You in Petroleum Marketing*, 1965.

    k. Publication 1545, *Opportunity Around the Corner*.

    l. Publication 1950, *Know Your Oil*. Price: 25¢.

    m. Publication 1615, *Installation of Underground Gasoline Storage Tanks and Piping at Service Stations*.

    n. Student booklet, *Careers in the Oil Industry*.

2. *The ABC's of Lubrication*, Ashland Oil and Refining Company, Ashland, Kentucky.

3. Glossary of terms relating to the lubricating grease industry, National Lubricating Grease Institute, Kansas City, Missouri.

4. Brower, G. K., Mezera, E. F., and Najt, R. F. *LP Gas Engine Fuel--"To be or not to be: That is the Question"*, reprint, 41st NGPA Convention, 1962, International Harvester Company, Melrose Park, Illinois.

5. Hoover, Norman K. *Handbook of Agricultural Occupations*, The Interstate Printers and Publishers, Inc., Danville, Illinois.

6. Kahil, P. *Additives in Lubricants*, SAE Journal, September, 1962, pp. 179-186.

7. *Lubricating Oil Classifications*, Technical Notes Series, The Ethyl Corporation of America, New York 20, New York.

8. *Motor Oil Additives and Their Functions*, Technical Notes Series, The Ethyl Corporation of America, New York.

9. Sauter, N. A. *Modern Farm Machines Need Modern Greases*, Agricultural Engineering Journal, January, 1956, reprints available.

10. *Selecting and Storing Tractor Fuels and Lubricants*, Southern Association of Agricultural Engineering and Vocational Agriculture, Athens, Georgia, 1964. Price: $1.25.

11. *Agricultural Machinery - Service Occupations*, The Center for Research and Leadership Development in Vocational and Technical Education, The Ohio State University, 980 Kinnear Road, Columbus, Ohio, 1965.

12. *LP Gas on the Farm*, National LP Gas Council, 79 W. Monroe St., Chicago, Illinois.

13. *Storage and Handling of Liquified Petroleum Gases* 1965, NFPA No. 58, National Fire Protection Association, 60 Batterymarch St., Boston, Massachusetts, 02110.

14. Career information available from major oil companies.

15. Rules and regulations for storage and transportation of liquid petroleum, available from the state fire marshal's office for respective states.

16. Publications from fire marshal's office and local distributors of oil companies pertaining to safety.

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IN VOCATIONAL AND TECHNICAL EDUCATION
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INSTRUCTOR NOTE: As soon as you have completed teaching each module, please record your reaction on this form and return to the above address.

1. Instructor's Name____

2. Name of school__________________________State______________

3. Course outline used:
   - _____Agriculture Supply--Sales and Service Occupations
   - _____Ornamental Horticulture--Service Occupations
   - _____Agricultural Machinery--Service Occupations

4. Name of module evaluated in this report__________________________

5. To what group (age and/or class description) was this material presented?____
____

6. How many students:
   - a) Were enrolled in class (total) ________
   - b) Participated in studying this module ________
   - c) Participated in a related occupational work experience program while you taught this module ________

7. Actual time spent teaching module:

Actual time spent teaching module:		Recommended time if you were to teach the module again:
_____hours	Classroom Instruction	_____hours
_____hours	Laboratory Experience	_____hours
_____hours	Occupational Experience (Average time for each student participating)	_____hours
_____hours	Total time	_____hours

(RESPOND TO THE FOLLOWING STATEMENTS WITH A CHECK (✓) ALONG THE LINE TO INDICATE YOUR BEST ESTIMATE.)

	VERY APPROPRIATE				NOT APPROPRIATE
8. The suggested time allotments given with this module were:	|____	.____	.____	.____	.____|
9. The suggestions for introducing this module were:	|____	.____	.____	.____	.____|
10. The suggested competencies to be developed were:	|____	.____	.____	.____	.____|
11. For your particular class situation, the level of subject matter content was:	|____	.____	.____	.____	.____|
12. The Suggested Teaching-Learning Activities were:	|____	.____	.____	.____	.____|
13. The Suggested Instructional Materials and References were:	|____	.____	.____	.____	.____|
14. The Suggested Occupational Experiences were:	|____	.____	.____	.____	.____|

(OVER)

15. Was the subject matter content sufficiently detailed to enable you to develop the desired degree of competency in the student? Yes____No____
Comments:

16. Was the subject matter content directly related to the type of occupational experience the student received? Yes_____No_____
Comments:

17. List any subject matter items which should be added or deleted:

18. List any additional instructional materials and references which you used or think appropriate:

19. List any additional Teaching-Learning Activities which you feel were particularly successful:

20. List any additional Occupational Work Experiences you used or feel appropriate:

21. What do you see as the major strength of this module?

22. What do you see as the major weakness of this module?

23. Other comments concerning this module:

(Date)

(Instructor's Signature)

(School Address)